VOLUME IV.

CONCRETE, EARTH DAMS, FLUMES, PIPE RIVETED, PIPE SUBMERGED

IN THE

District Court of the United States

FOR THE

Northern District of California

SECOND DIVISION

SPRING VALLEY WATER COMPANY,
Plaintiff,

vs.

CITY AND COUNTY OF SAN FRANCISCO, ET AL.,
Defendants.

Nos. 14,735, 14,892, 15,131, 15,344, 15,569, Circuit Court of U. S., Ninth Judicial Circuit, Northern District of California, and 26 and 96 District Court of U. S. Northern District of California, Second Division.

ABSTRACT OF TESTIMONY TAKEN BEFORE HONORABLE H. M. WRIGHT, STANDING MASTER IN CHANCERY FOR THE DISTRICT COURT OF THE UNITED STATES IN AND FOR THE NORTHERN DISTRICT OF CALIFORNIA, SECOND DIVISION, IN THE PROCEEDING ENTITLED SPRING VALLEY WATER COMPANY vs. THE CITY AND COUNTY OF SAN FRANCISCO, ET AL., IN EQUITY NOS. AS ABOVE.

For Defendants:
PERCY V. LONG, ESQ.
ROBERT M. SEARLS, ESQ.

EDWARD J. MCCUTCHEN, ESQ.,
WARREN OLNEY, JR., ESQ.,
A. C. GREENE, ESQ.,
Solicitors for Plaintiff.

NEAL PUBLISHING COMPANY, PRINTERS, SAN FRANCISCO

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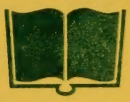

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SIXTIETH HEARING. NOVEMBER 15, 1915.

Witnesses: ALLEN HAZEN, for Plaintiff.
LEONARD METCALF, for Plaintiff.
J. H. DOCKWEILER, for Defendant.

Ruling on reserved ruling with respect to the devisees of the O'Rourke Estate, in favor of the City. 4158-9

No agreement has been reached as to valuation of properties prior to year 1913 so far as San Francisco is concerned, and this includes the Merced property. No definite agreement with regard to Pleasanton property.

Witness: ALLEN HAZEN, for Plaintiff.

DIRECT EXAMINATION BY MR. GREENE. 4163

I reside in Dobbs Ferry; my office is in New York City. I am 46 years old, and was educated at the schools in Vermont, at the New Hampshire State College, at the Institute of Technology, Mass., and attended The Royal Technical Highschool, at Dresden, Germany, taking a course in waterworks construction. I am a civil engineer. My first work was at the Lawrence Experiment Station for the Massachusetts State Board of Health. I was there for 5 years carrying out experiments with reference to water supply and sewerage, and also having something to do with the supervision of the water supply and sewerage of the cities of the State. In 1893 was in the Department of Water Supply, Sewerage and Fire Protection of the World's Columbian Exposition at Chicago. 1894 I spent in Europe visiting water works, and putting in one semester at Dresden. In 1895 I entered private practice in Boston with the firm of Noyes and Hazen, which continued for two years. In 1904 the firm of Hazen and Whipple was formed, being now the firm of Hazen, Whipple & Fuller. 4164

I am a member of the American Society of Civil Engineers, and have been a director of that society; I am a member of the American Institute of Consulting Engineers, and of the governing body of the Institute at this time. I am a member of the American Public Health Association; The American Waterworks Association, of which I am a member of the governing board; The New England Waterworks Association; The Boston Society of Civil Engineers; The Franklin Institute, and also the French Society of Waterworks Engineers. 4165

I have written several books. The first is called "The Filtration of Public Water Supplies", which came out in 1895. Also a book called "Clean water and how to get it". With Professor Gardner S. Williams, I prepared a volume of hydraulic tables. I wrote the chapter on "Water supply and sewerage" in the American Civil Engineers Pocketbook. I have written articles for technical papers and

societies on very numerous occasions. My business has been mainly in connection with public water supplies, and I have been employed by cities and water companies, and sometimes by other parties interested in those matters. The problems have been finding out what conditions are, or were, what it is best to do, finding out what new works would cost, finding out what works should be built, and in many cases
4166 making the detailed plans and specifications for construction, and superintending the construction, and in fact, supervising them in the interest of the principals to its finish. The advisory work has been of much broader nature than the construction. We have advised with reference to a great many water supplies pretty well all over the country, and some outside the country.

At Albany, N. Y., I designed and supervised the construction of an addition to the waterworks plant. At Auburn, N. Y., I advised with regard to extending and improving the water supply, and designed an addition to the plant. At Augusta, Maine, helped the city in acquiring the works of the water company, advised as to a new supply, and gave a general plan for it. At Austin, Texas, advised with regard to water supply, and made some designs for additional works. At Baltimore, Md., advised with reference to increasing the supply; also at Bangor, Me., at Battle Creek, Mich., and at Bethlehem, Penn. At Brisbane, Australia, examined the system, and advised as to best method of extending it; made plans for parts of the additional works, which have been carried out in part, and are being com-
4167 pleted at this time.

At Burlington, N. J., advised as to additional supply. At Charleston, S. C., advised city with reference to works which were owned by a company. At Chester, Penn., advised city several times with reference to matters affecting its relations with the company which owns the works. At East Orange, N. J., advised city with reference particularly to its water rights, and matters in controversy growing out of the diversion of water. At Grand Rapids, Mich., in company with Mr. Gray, of Providence, I advised the additional water supply. At Greenfield, Mass., advised as to additional water supply, and helped make the arrangements which have since been carried out. At Hackensack, the Hackensack Water Co. supplied Hoboken, and many other cities in New Jersey. I advised as to increasing and improving the water supply. Hartford, Conn., advised as to all sorts of matters relating to waterworks, operation and extension, during a period of ten years, and worked out a new scheme of supply, which is being built at the present time. The Hudson River Hospital, at Poughkeepsie, we have advised as to water supply, and have designed and superintended the construction of several additions to their plant. Hudson, N. Y., advised as to the extension of water supply. Indianapolis, made a project for the water company for additional water supply many years ago, which was afterwards carried out with some

modifications. At Ithaca, designed additional works for the water company, and assisted the company in the valuation of the plant, and in the procedure which led to the acquisition of the plant by the city. 4168
Kingston, N. Y., advised as to water supply; also at Lancaster, Penn., Lima, O., and Lynn, Mass. At Minneapolis with two other engineers, a project for improving the supply was made which has since been carried out with some modifications. New Brunswick, N. J., advised as to water supply; also at Newberg, N. Y.

In New York City, have served in a great variety of capacities in connection with its water supply, and was employed to appraise the plants of three water companies within the city limits. I served them in the negotiations that followed, until two of the plants were acquired by the city without litigation. At Norfolk, Va., advised the city on the whole subject of water supply, and the means of handling the plant and developing it. Nyack, N. Y., designed an addition to the plant many years ago, which was built by another engineer, and have since advised as to matters of operation. Ogdensberg, N. Y., advised city as to developing a plant, and afterwards made plans for and supervised the construction of additions. Ottawa, Canada, advised city various times as to waterworks, and best method of extending them. Made a design of an important addition to the plant, which has not been built as yet. The Palmer Water Company, Pennsylvania, subsidiary of the New Jersey Zinc Co., have acted as en- 4169
gineering advisors for a good many years, and have designed and built structures for them from time to time. Peekskill, N. Y., designed an addition to the plant, and acted in a consulting capacity during its construction. Peoples Water Company, Oakland; gave some advice to the reorganization committee last year, and have helped them since that time in some matters. Philadelphia, have given advice as to some secondary matters connected with the water supply. Once advised a committee of citizens as to the main question of Philadelphia's water supply. Pittsburg, Penn., was employed by the city a dozen years ago making extensive studies of the available sources of supply for the increasing population, and I blocked out in a general way the works which have since been built. The Plainfield Union Water Co., employed us from time to time with reference to possible sources of additional supply. Portland, Me., acted as Chief Engineer for a water district, and gave assistance in various matters, and finally appraised the plant of the Portland Water Company, and its subsidiary companies, in which I was aided by Mr. Metcalf, and followed the business through until the works were acquired by the water district. Afterwards I designed for the district important extensions to the 4170
system, which have since been built.

Questioned by Master.

Those are the cases that are in Law Reports, and Judge Savage was Chairman of the Commission that handled the matter. The Court

appointed a commission of three, of which Judge Savage was chairman, to hear the evidence.

DIRECT EXAMINATION BY MR. GREENE.

Poughkeepsie, N. Y., advised the city with reference to waterworks through a good many years covering a new source of supply, development of their present sources, the distribution system, fire protection; we are retained, and are advising them all the time on
4171 these matters at the present time. Reading, Penn., advised as to the extension of the water supply, and made a project for extending it which has since been carried out. St. Albans, Vt., advised as to water supply, and made general plans for some improvements which have been carried out. St. Louis, Mo., was member of an engineering board of three to report on best means of increasing and improving the water supply, and made a minority report. I recommended substantially the method of carrying out the improvements that have since been followed. St. Paul, Minn., advised as to best means of improving the water supply, and made a general program for extending the system. Salem-Beverly, Mass., we are acting as engineers for the water district which has been formed to get additional water supply for the two cities, advising them on all their engineering questions, and have made plans for a part of the new works that will be required. We are supervising the construction, and the work is under way at the present time. I was employed by the City of San Francisco four years ago to make an estimate of the cost of introducing water from the Sacramento River, and on certain other matters. Springfield, Mass., advised the city as to water supply matters, and finally recommended an entirely new source of supply, which was
4172 adopted. We made all the plans and specifications for this work, and the construction was done under our general advice. This work included not only an entirely new source of supply, but the reconstruction of the distribution system. Superior, Wis., acted as engineer for the water company for nearly 20 years, and have advised them with regard to all the problems that have come up. Have designed and supervised the construction of all their new works, which covered the ordinary variety of waterworks structures.

Toledo, O., I was a member of the board of engineers that recommended the means of extending and improving the city supply that has subsequently been carried out. Trenton, N. J., advised the city as to the best means of improving and increasing its supply. Washington, D. C., have advised the army engineers in whose charge the water supply work is placed. I aided them in the design of the Washington Filters, and in the construction of the work. Watertown, N. Y., have advised the city as to water supply matters, and designed and superintended the construction of an important addition to the plant some ten years ago. West Point, N. Y., the United States Mili-

tary Academy; I have advised the army engineers as to additional and improved water supply. Winnipeg, Canada, I have advised as 4173
to an additional water supply. At Toronto I made plans and specifications for the filter plant which was built, and in an advisory capacity supervised the construction. Yonkers, N. Y., advised the city as to additional water supply, and have designed and superintended the construction of quite a number of additions to the water works plant through a term of ten or twelve years.

At the present time we are advising continuously with reference to operations in the routine difficulties that come up in waterworks plants at Miami, Fla.; Poughkeepsie, N. Y., Superior, Wis., and Watertown, N. Y. I have advised with reference to the Charles River Dam some years ago, in the Charles River, which flows between Boston and Cambridge, Mass.

Questioned by Master.

The Charles River Dam is an earth structure between Boston and Cambridge, built a few years ago. 4174

DIRECT EXAMINATION BY MR. GREENE.

I served as a member of an engineering commission to report on the Florida Everglades a few years ago. I was a member of a board of engineers in 1909 reporting to President Roosevelt on the Gatun Dam, and the general condition of the work at the Isthmus.

At Athol, Mass., I valued the plant for the city. Augusta, Me., I was employed by the city in connection with the appraisal of the plant, although I did not make a separate appraisal. Cortland, N. Y., I appraised the plant for the water company, and conducted negotiations which finally led to its sale to the city without litigation. Denver; was a member of a board of 5 engineers which acted jointly 4175
for the city and the company, and which appraised the plant some years ago. Des Moines; appraised the plant for the company, and appeared for them in the litigation which followed. Gardner, Mass., appraised the plant for the water company, which was afterwards taken by the city. Gloucester, Mass., and Newburyport, Mass., I did work for the cities in connection with valuations. Ithaca, N. Y., valued the plant for the company, and aided them in the litigation which ended in the plants being taken by the city. Racine, Wis., valued the plant for the company. Staten Island Companies; I valued them for the City of New York. Waverly, N. Y., I valued the plant for the company, and aided them in the procedure which led to its final transfer. I also valued the plant of the Wildwood Waterworks. Wilmington, N. C., I valued the plant for the water company. That was something of an arbitration procedure; I represented the water company, and the city selected an engineer, and the two of us acted together, and as a result the plant was finally sold to the city without litigation. Bergen County, N. J., my firm has been

making a valuation of the Hackensack Water Company's plant, and
4176 is engaged by the county in a rate suit. At Spot Pond, I was employed by the Metropolitan Water Board, virtually a water district, in the condemnation of Spot Pond, owned by the three cities in the district. The principal question at issue was the value of the water or water rights.

Questioned by Master.

That was in Massachusetts. At Denver, the object of the appraisal was for the purpose of purchase, and the appraisal was provided for in the company's charter, and it was provided that this appraisal should be made in a certain way at a certain time, and we made it; the plant has not been transferred up to the present time. That was followed by a rate-fixing procedure, and I testified briefly in the rate case. At Des Moines it was a condemnation suit, and the Court fixed the value of the plant, but the city did not vote the money to purchase it, and the company still has it. The Racine case is a condemnation case, and still pending. The Bergen County case is a rate case. I think all of the others have been transferred as a result of following the procedure.

4177 DIRECT EXAMINATION BY MR. GREENE.

I arrived in San Francisco March 14th, 1914, to take up the Spring Valley's business, and spent from that date until the first of June in San Francisco, studying the properties on the ground, records, inventories, and everything that I could find on the value of the property. I was again in San Francisco on July 7, 1914, and remained until August 10. In addition quite a little time was spent in New York on Spring Valley business during 1914. I came out in April, 1915, remained until about the first of June, came out again in July, and was here for a little while, and then came out again in September; with the exception of perhaps three weeks away from San Francisco, I have been here since that time.

Questioned by Master.

I spent a great deal of time over the whole system. I walked over a good deal of it, and the only reason I did not walk over all of it was the shortness of time, and the need of getting certain things closed up, so there are some parts of the pipe lines and flumes I did not walk over.

DIRECT EXAMINATION BY MR. GREENE.

I think I am as familiar with the entire system as it is possible for any person on the outside to be in a reasonable limit of time.

4178 CROSS EXAMINATION BY MR. SEARLS.

In the Denver rate case I stated what in my judgment the value of the plant was approximately, based upon the appraisal made by the board before, and taking into account briefly the depreciation

that had accrued since that time, and the new construction which had been carried out, which I saw and examined the vouchers for. My report on the Sacramento River project for the City of San Francisco was comprised in the volume marked "Hetch-Hetchy Water Supply for San Francisco, 1912," commonly known as the Freeman Report, and outside of those two matters I have not made any water plant appraisals west of Denver.

The Peoples Water Co. plant had been appraised in great detail by the two Cory Bros., and I was employed by the re-organization committee to advise them on some general matters, and to help the Corys in some matters in connection with their appraisal. I did not make a separate, independent examination of the whole property. 4179

Questioned by Mr. Greene.

I have made inspections of waterworks plants at Sacramento, Los Angeles, Portland, Seattle, Victoria, and Vancouver, during the present year. I have seen some of these plants at various earlier periods.

Witness: LEONARD METCALF, for Plaintiff. Metcalf

DIRECT EXAMINATION BY MR. GREENE. 4180

I reside in Concord, Mass., and am 45 years of age. I graduated from Massachusetts Institute of Technology in 1892, and entered the employ of Wheeler & Parks, waterworks builders and operators, located in Boston, Mass. They had built 14 or 15 plants in different parts of the country which they were operating, and I was sent to various of these plants to make surveys and supervise construction and matters relating to their operation. In 1895 I left their employ to take up teaching, having charge of the department of mathematics and engineering at the Massachusetts Agricultural College. I was in charge of the Meteorological Bureau of the Hatch Experiment Station at Amherst, and remained there for two years. I returned to Boston, and engaged in general engineering practice, and have been located there since that time.

In 1907 I took into partnership Mr. Harrison P. Eddy, of Worcester, and have done engineering work under the firm name of Metcalf & Eddy since that time, principally along waterworks and sanitary lines. We have had charge of the operation and management of certain waterworks properties during the years of 1904 to 1913 for certain bond holders who had controlling interests in these properties, carrying on the management until the properties were built up and sold, or disposed of for the bond holders.

I am a member of the American Society of Civil Engineers, of which I am a director at the present time, and of the American Society of Mechanical Engineers; the American Waterworks Association, of

4181 which I am vice president; the New England Waterworks Association, of which I am president, and some others. I have written a number of professional papers that have appeared in the different engineering journals and society publications; we recently have been getting out a three-volume book on "American Sewerage Practice".

I had charge of the bond holders' interests in the works at East Chicago, and Indiana Harbor; the plants covering not only the waterworks, but also the light and power systems of the city. At Vincennes, Ind., I operated the City Electric Light Co., and subsequently sold it, as I did the East Chicago and Indiana Harbor plants. I negotiated the purchase of the Vincennes Electric Co. from the old gas company, and my partner, Mr. Sherman, operated that plant for several years until I sold it with the others. I sold the water and light plant in Churubusco, Ind., and also the Valley Junction plant. At Albany, Ind., we had the water and light property which we operated for a nine year period. Centerville, Ia.; waterworks which we operated and finally sold to other bond holders, who rebuilt the plant
4182 along lines which had been laid out by me.

I had general charge of the bond holders' interest in Waupaca, Wis., and at Lincoln, and Gas City, Ind., although I did not actually operate those properties. I was instrumental in the sale of the Indianapolis Water Company works, which were sold by one of my clients, and bought by another, and since that time I have advised them with regards to questions of policy, management and construction. I have given advice to from 75 to 100 different waterworks plants on matters of construction and operation, amongst these the plant at Albany, Ind., the Baltimore County plants surrounding the City of Baltimore. At Boston we investigated the water, sewer and street departments for a period of about two years for the Boston Finance Commission, particularly upon questions of the administration and operation of those departments. That commission was appointed by the mayor, and there grew out of it the new charter, under which the city has a finance commission, and there is a finance commission today by which we have been called in in some minor matters since that time.

Boulder, Colo.; I have reported to the municipal authorities on
4183 the sewerage and water front problem. Bristol, Conn., advised the water company on all construction matters, up to the final valuation and sale of their plant to the municipality. Brunswick, Me.; have advised the municipal authorities since the purchase from the Brunswick & Topsham Co., with regard to pipe extensions and other works. Centerville, Iowa; I supervised the operation of the plant for some years, and made plans for a new source of supply, which has been built. Concord, Mass.; I have advised the municipality from time to time, and have had charge of the design and construction of the additional water supply, and the high service reservoir and fire protection

system, and am now a member of the water board there. Columbia, Tenn.; acted on a board of arbitration between the city and the company, which has led to a settlement of the issues there recently.

Dennison, O.; advised the water company with regard to the rate problem, and designed a new intake and dam, piping system, and so on, and advised them for some years in matters of operation. Denver, Colo.; was called in with Mr. Hazen to advise on question of water rights, which was up before the commission passing upon the water rights of the state. Subsequently had charge of the valuation recently of the properties of the company, and which finally led to my testifying in the rate case, a decision upon which has recently 4184
been rendered for the water company. Derry, Penn.; I have made plans for pumping plant changes for private works. Des Moines, Ia.; was called in in the proceedings looking towards the purchase of the works by the municipality, valuing the property, and so on. Dover, N. H.; I have advised the municipality with regard to additional source of supply. Fitchburg, Mass.; we have recently reported—in my absence—upon additional water supply, but I have only given advice in regard to some matters of policy affecting the new construction; one of the dams and dikes has recently been completed. In Florida I was called in with Mr. Hazen and Prof. Mead to report some years ago on a drainage problem in the Florida Everglades. Fort Wayne, Ind.; reported upon the water front and sewer problem, laying out plans for construction work which the city is planning to build. I was consulted there by the City Improvement Association, which was co-operating with the city authorities.

Greensburg, Penn.; advised for a number of years the Westmoreland and allied water companies, supplying a string of 8 or 10 cities within a radius of about 30 miles east of Pittsburg, in matters of construction and operation, preparing plans which were subsequently 4185
executed. Hamilton, Mass.; reported upon the water supply, and also at Hallowell, Me. Hurley, Wis., and Ironwood, Mich., reported upon the necessary changes to meet the issue between the company and the city, which led to some negotiations with the city under which the situation was straightened out, I believe. I have had to do with the works at Indianapolis in an advisory capacity for several years, and made a valuation of the property looking toward the proper keeping of their books under the requirements of the Public Utilities Commission. Ipswich, and some neighboring communities; have advised with regard to their water situation in the matter which was recently pending in the development of a supply for the cities in that district. Las Vegas, N. M.; designed and superintended the construction of a dam for the water company. Lincoln, Mass., advised the municipal authorities concerning the metering of the supply, and details of operation. Macon, Ga.; was one of "three disinterested hydraulic engineers", acting as an arbitrator in the valuation of the waterworks.

4186 These works were taken by the city. Mattapoisett, Mass.; advised making plans for waterworks, and the disposal of sewage.

Milton and Hopedale, Mass.; have advised water companies for some years, and the Draper Company, with regard to construction matters and operation, and questions of rate. Have designed and built their filtration plant, a dam for additional supply, reinforcement of pipe system, and a new pumping station. Milford, N. H.; made plans and supervised the construction of additional supply for the city. Milton, Mass.; advised on matters of the conservation of their supply and the metering of the system. In Cuba I advised the United Fruit Co. on the development of sources of supply for the irrigation of their cane fields. North Conway, N. H.; assisted another engineer in the valuation of the property, which was taken by the municipality, and which finally led to my testifying in those proceedings for the municipality.

I had charge of the valuation of the properties of the New Jersey General Securities Co. and acted for the company in presenting the matter before the board of engineers that was appointed by the water supply commission to value these properties, looking towards their
4187 purchase by that commission. The works have not yet been taken. Phoenix, R. I.; advised the private works in matters of operation, and the value of the property. Nashua, N. H.; advised the water company with regard to some questions of management; valued the properties, and have prepared to present the matter before their state board. Needham, Mass.; recently made plans for the construction of a stand pipe, and some reinforcement of the pipe system. Newport, R. I.; we have had to do with the valuation of the property, but that has been done during my absence here. Portland, Me.; assisted Mr. Hazen in the valuation of the works which were taken by the Portland Water District. Proctor, Vt.; reported upon additional supply along lines which I believe have been followed in construction. That was municipal employment. Providence, R. I.; built a dam and some other works for large manufacturing establishments for water supply, and also filter beds and disposal works for the disposal of their wastes, aggregating several million gallons a day. Rockport, Me.; advised the municipality on certain matters relating to their waterworks, and the question of taxation of their works. Rum Ford Falls, Me.; was called by the municipality at the time of the formation of the Rum Ford Falls and Mexico Water District, and valued that property, and testified in the proceedings leading to the taking of the plant. Subse-
4188 quently was retained to make plans for the development of new sources of supply which have since been developed by the municipality.

San Antonio, Tex.; reported upon the value of the property for banking interests, and was recalled by the company to represent it in negotiations with another engineer representing the municipality, in determining the terms of a fair basis for contract upon the rate

question with the city. At San Jose, Costa Rica; I made a report for the United Fruit Co., and the government, upon a water supply, sewerage system, and some power development, along lines which have since been followed I believe, in construction. Scranton, Penn.; valued the waterworks supplying the city, and twelve or fifteen adjoining towns and cities. Taunton, Mass.; was called by the municipality to investigate questions of power diversion from the city supply.

I was called by the Kennebec Water District at the time of the taking of the properties by the municipality from the water company, assisting Mr. Freeman, Mr. Coffin, and others in the getting together of their data. I did not testify in that case. I was subsequently called to build their new works, with a new source of supply from China Lake, and conduits and other structures of the distribution pipe system, and the building of an auxiliary steam pumping plant. I was recently called to design a masonry dam; also to design an auxiliary steam pumping plant. Wellesley, Mass.; we have been called by the 4189
waterworks and several times on the question of sewage disposal. I examined the properties at Wilkesbarre, and 12 or 15 adjoining communities with a view to purchase by clients. I examined the property at Wilkinsburg, Penn., which supplies that city and 8 or 10 adjoining communities, and finally valued the properties and took part in the rate proceedings for the company.

In addition to these there are a number of smaller works which we have advised in one way or another concerning questions of operation or construction. In the valuation of the waterworks properties I have referred to, certain works I represented, or acted for the municipality—in the case of the Kennebec Water District, in Maine; the Kittery Water District in Maine; the Livermore Falls Water District in Maine; the New Market Water Works, N. H.; the North Conway, N. H., water works; the Portland Water District, Maine; and the Rumford & Mexico Water District, Maine.

I was called as a witness, and valued the properties for the water companies in Denver, Des Moines, Bristol, Conn., the Pennsylvania Water Co., in Wilkinsburg; the San Antonio; and the Newport, R. I. In Columbia I acted as arbitrator. We were called in other cases such as at Waltham, Mass., by the municipality, to assist them in their rate schedules. I have acted as arbitrator in the valuations of the properties of the Nashoba Mfg. Co., near Boston, one of the properties condemned by the Metropolitan Water District; also at Macon, Ga., and at Columbia, Tenn., and in arbitration proceedings at Chicago, on the condemnation of the plant of the Chicago Reduction Co. I sup-
pose I have given 40 or 50 municipalities advice on the subject of 4190
sewerage work and sewage disposal.

I came out here first in connection with the Spring Valley Water Co. in the fall of 1913, and spent two weeks in going over the property, and outlined the preparation of an inventory. I returned in Decem-

ber, and spent a week or ten days in work of a like nature. About March, 1914, I came out here and remained 4 or 5 months, making an examination of the property and the records of the company. I finally came out in the middle of May of this year, and have been here practically the greater part of the time since then, making a valuation of the properties of the company. When I came out here in March of last year, I was here about 5 or 6 months. Since I came here in May of this year, I was gone for two weeks when I went east, and I made a trip to see the Modesto and Turlock irrigation works,
4191 the Sacramento work, and the Portland, Seattle, Victoria and Vancouver work. During that time I have also been to Los Angeles, San Diego, and Imperial Valley, and have seen something of the public works in those cities.

My examination of the Spring Valley properties I have made with some care. I have walked over considerable parts of the plant, or ridden over it, and have seen the various structures, and such portions of it as were visible, as carefully as I could in the time that was available. The inventory was prepared under my direction in co-operation with a representative of the city.

CROSS EXAMINATION BY MR. SEARLS.

The pamphlet "Twelve Years Professional Work", shows all the cities in which I was employed, I think, up to the time of its issue, in a general way. The only cities in the west in which I have made any extended investigation are Denver, Colo., Las Vegas, N. M., and San Antonio, Texas. I was on railroad work some years ago in Idaho and Washington on the engineering side, and that is true of the work I did at Boulder, Colorado. The cases in which I have testified have been equally divided, I think, between the side of the water company, and
4192 the municipality. There have been but few rate cases, and in those I have appeared for the water company, except in the case of Waltham, where we were called to advise the city, but owing to my absence, I have not been able to give that very much personal attention.

Dockweiler Witness: J. H. DOCKWEILER, for Defendant.

DIRECT EXAMINATION BY MR. SEARLS.

4193 I am a consulting engineer residing in the City of San Francisco, and am 51 years of age. I began engineering as a student in 1881, and have been following the lines of engineering ever since that time. During 1884 and 1885 I studied at St. Vincent's College, Los Angeles. Previous to that I had worked on surveying parties, and on the construction of a railroad. After leaving school I worked as a deputy until the spring of 1887 in the office of the City Engineer of Los Angeles. In 1887 I opened an office in Los Angeles, and up to 1889 was

employed in general surveying work. During that period I was also employed as an assistant engineer on the construction of the Los Angeles Cable Railway System. In 1889 I became City Surveyor of Los Angeles. I made the designs for the Third Street Tunnel in that city, which was built on my plan. I made the surveys and estimates for a proposed line of outfall sewer from Los Angeles to the Pacific Ocean at Long Beach. I advised against the construction of this line. From 1891 to 1894 I served as City Engineer of Los Angeles, during which time I made a report and estimate on the proposed waterworks for Los Angeles. During that time I designed and constructed the 4194
outfall sewer from Los Angeles to the Pacific Ocean, and there was a great deal of work for the city in the construction of bridges, the laying of a great many miles of sewers and pavements.

The outfall sewer is about 12½ miles long, and constructed of brick, concrete, and wood stave pipe; at the outlet there was cast iron pipe. I think there were three tunnels on the route. One was about a mile long, and the others probably under 1,000 feet each in length. While City Engineer I selected the site for the present upper head works, or intake for the water supply of Los Angeles on the Los Angeles River. During 1895 and 1896 I was engaged in private practice, and did considerable estimating for various contractors who were bidding on work of different kinds in Southern California. In 1897 I became City Engineer again, serving during 1897 and 1898, and during this time I completed plans and estimates for the cost of a proposed waterworks for Los Angeles. These works were not constructed, but some of the general designs have been built and consolidated into the present waterworks as they exist in the city today. In 1897 I made the appraisal for the Los Angeles City Council of the physical structures of the Los Angeles Water Works. I also designed the Broadway Tunnel, which was about 900 feet long, and 40 feet in 4195
the clear. This was built by my successor. I retired as City Engineer in January 1899.

In 1899 I became consulting engineer to provide a water supply for the King of Arizona Mine. The water supply at the time consisted of three wells, about 1,000 feet deep each, and lifting the water out of these wells by means of pumps, and then pumping that water through several miles of pipe to the mine. Between 1899 and 1904 I specialized in investigating mining properties in California, British Columbia, Nevada, Arizona and Mexico. I have had charge of the driving of tunnels and the sinking of shafts for mining companies. In 1904 I was employed by the City Attorney of San Francisco, on the appraisal of the properties of the Spring Valley Water Co. During 1904 and 1905 I was continuously engaged in the investigation of the properties of that company. I testified in the 1903 and 1904 rate case. In the early part of 1906 I was engaged by the City of Oakland to appraise the plant of the Contra Costa Water Company, and am still

employed by the City of Oakland as Consulting Engineer. I have had continuous employment since 1906 from the City of Oakland, either in the capacity of consulting engineer, advisor to the attorneys engaged in litigation, or in the capacity of advisor to the City Council of Oakland on matters of water supply and rate fixing.

4196 I made an appraisal for the City Council at San Rafael of that part of the plant of the Marin Water & Power Co., used in supplying the City of San Rafael with water. I was subsequently employed by the Marin Municipal Water District to make an appraisal of the entire properties of the Marin Water & Power Co. I made an appraisal on behalf of the Watsonville Water, Light & Power Co., of its plant, used in supplying Watsonville with water. I also prepared plans for the improvement of the company's works. I made a report with reference to the Modesto and Turlock Irrigation District regarding water supply, which was prepared on behalf of the City of San Francisco. I made a report on the condition of the water supply of the Niles Cone in Alameda County. I reported on the project of supplying water to the City of San Francisco, and other communities around the bay region, from the American-Consumnes River. That report was prepared at the request of the City. I prepared a report jointly on behalf of the cities of Oakland and Berkeley with San Francisco, on the condition of the water supply in the east region of San Francisco Bay. This is an exhaustive study of all nearby sources of water supply in use, and proposed for said communities.

I prepared a report for the City of San Francisco on the water rights and filings on the Tuolumne River. These five reports were

4197 incidental to the showing which the City of San Francisco was called upon by the Secretary of the Interior to make in the matter of the Hetch-Hetchy water supply. I made an appraisal of all their properties used in the supplying of water to the irrigation territory near Merced, for the Crocker-Huffman Land & Water Co. This appraisal was submitted to the Railroad Commission, but no determination of the issues involved has as yet been made. I prepared for the East Side Irrigation District an appraisal of the physical structures in their plant. This was also before the State Railway Commission. I prepared a report for the La Mesa & Spring Valley Irrigation Districts in San Diego County, on the valuation of the physical properties of the Cuyamaca Water System. This was heard before the Railroad Commission.

In the last two years over one-half of my time has been spent in preparing, among other things, an inventory and appraisal for sale purpose of the properties of the Spring Valley Water Co., which were comprised in the offer entered into between the City of San Francisco and the water company for the sale of that property. This appraisal included all physical structures, and did not differentiate

as to whether those properties were in use or not. If I recall correctly, I commenced my work on that inventory and appraisal about the latter part of 1913. There was almost continuous employment 4198
on that work for nearly a year, and in the course of preparation I examined the physical structures of the Spring Valley Water Co. sufficiently to justify me in coming to an agreement as to the various items that constituted the physical structures of the Spring Valley Water Co. I had a great many assistants who went over and made the actual physical measurements, but I examined the properties in addition, myself. I walked over a great many of the properties, and have had a fairly intimate acquaintance with the company's properties for the past 11 years. As a result of my experience and studies, I have become especially familiar with costs of material and labor in the bay region, and particularly with material and labor which would be, or are employed in the construction of a water supply system. I prepared, at the request of the City Attorney's Office, a complete appraisal of the physical structures of the Spring Valley Water Co. at the time of the sale. The appraisal for use in this case is not finally completed, but a great deal of the 4199
work which was done for that valuation proceedings I will employ in determining values for this rate suit.

CROSS EXAMINATION BY MR. MCCUTCHEN.

The first time I retired from office of City Engineer of Los Angeles was in the beginning of 1895, and the second time in the beginning of 1899. I have maintained an office practically from 1899 up to the present time, and have been engaged in the practice of my profession as a civil engineer. In 1904 and 1905 I was in the employ of the City Attorney of San Francisco, and did not have an independent office. In the beginning of 1906 I had an office on California Street which was destroyed during the fire. Shortly after the fire I opened up an office, and have had one continuously ever since, and I think it has been a matter of common knowledge that I was engaged in the practice of civil engineering during all that time.

Referring to engineering work that I did, or that was done under my direction, other than appraisals, from 1904 on: I think 4200
there was one pipe line laid by the Watsonville Water & Power Co. on my design. Recently I have built a reclamation district over in San Rafael, to reclaim about 800 acres, which consisted in the construction of a levee to keep the tides out; also the construction of a pumping station to pump the water out of that reclaimed piece. The water that we wanted to keep out was the tide water, and also the direct rain, and the run-off which came upon that land from the adjoining hillside. The land is at St. Vincent's Orphan Asylum, San Rafael. The levee was about a mile and a half long, six feet wide on top, and probably three feet high, with the natural slopes

that the mud would have after its being deposited out of the dipper by the dredge. I prepared plans for that work, and made an estimate on the cost of doing the work. I also made a general call of specifications for a pumping station to lift the water out of the
4201 station which you create on the inside of the levee, and pump it out into the seaside. The pump had a capacity of about 20,000,000 gallons a day, was operated by electricity, and is still there. It is a Price Centrifugal, and was specially built, but not on my design. The designs were submitted by the builder in response to a call for bids, and the Price people were the successful bidders, and the pump was built in this city. The motor that operated the pump was 75 horse power. I made the general design for a small building to
4202 house the pump. There was an electric power line leading to that plant, but I had nothing to do with that.

With reference to the Watsonville plant; I think Mr. Smith informed me that he had bought the pipe, but I never went on the job to ascertain whether the pipe was laid or not, so that whether anything was done on my plans there is purely a matter of hearsay.

With the exception of these two pieces of work, at the St. Vincent Orphanage, at San Rafael, and the possible laying of pipe as part of the Watsonville plant, I have had no charge whatever, nor anything to do with any engineering work since 1899 that was built under anything I designed. I have been employed indirectly with
4203 reference to engineering work in the course of construction since 1899. I was employed by the City of Oakland to ascertain the cost of all the work that the Contra Costa Company was doing as far as that work pertains to the Oakland division of the Peoples Water Co., but for a period running from about October, 1908, to June, 1914, I reported every two months to the City Council of Oakland, in writing, upon every piece of work which was done by that company. This work embraced the cost of laying pipes of various kinds, and the construction of a dam. I cannot say that I was identified with any work, except in this way; as the representative of the city in ascertaining the cost of the work. I had nothing to do with the direction of the work, or the designing of it, but was an outsider who was very well posted on the cost of the work.

Between 1899 and 1904, I specialized as a mining expert, but
4204 I was not engaged in the business of hydraulic or civil engineering. In looking over a great many of these propositions, a man drew upon whatever knowledge and experience he had in the consideration of some of the problems that would arise; for instance, there was a question of the installation of a water supply, or a power plant, and it is a fair statement to say that it was an investigation of mining properties. So far as that involved a consideration of the utilization of water, it did not mean anything more than putting a little dam in a gulch and conveying the water through a pipe to

a mill or compressor. I am still engaged by the City of Oakland as consulting engineer, and I am subject to their call to appear in court and give such testimony as they request, and also to advise with them, prepare valuations, and do whatever work an engineer would be called upon to do in such employment.

Questioned by Master.

In connection with my mining experience, I did some tunnel 4205
work. I actually operated some properties; I was on one property in Fresno County for about a year, during which time I drove probably 300 feet of tunnels, and sunk a shaft through a very hard schistose slate, probably about 80 feet in depth.

CROSS EXAMINATION BY MR. MCCUTCHEN.

That Fresno property was owned by the Wabash Mining Co., of which I was superintendent. There were two tunnels, each about 300 feet long, probably 6 feet high, and 3½ or 4 feet wide. I had a track in them, and operated a car as to some parts of it. As to the rest, I ran the muck out with wheelbarrows, and the material through which we drove that tunnel was slate. Some of it was rather blocky slate, and other parts of it developed into schistose slate. I used single track until I struck the hard stuff, and then I used a double, and in sinking my shaft, I used a steam drill. I sunk part of it by single jack work, and the balance by a baby drill. It 4206
was an incline shaft of about 65 or 70 degrees off the vertical. The shaft was about 6 feet wide, and probably 8 feet long.

I was consulting engineer on the Tonopah, and we sunk a vertical shaft there about 962 feet deep. About 140 feet of it had been run before I acquired control of the property. That was the Little Tonopah Development Co., and we started to sink that shaft about 1904. I have not had very much experience as consulting engineer with the mining companies. This company had a superintendent, and I did not have to tell that superintendent how to sink that shaft, but I happened to be interested in the company, and I went up to Tonopah and laid out the plan of developing the property, and recommended the sinking of the shaft. I did not have anything to do with the actual physical labor of sinking it, but I went up there several times while the work was proceeding. I did not draw any 4207
plans and specifications for sinking that shaft. I simply stated that the present shaft which was, I think, 140 feet deep at the time we bought the property, ought to be continued down, and the company agreed with me. I did not have anything to do with the plant that was installed, other than stating that I thought that such and such a size plant would do the work. The ordinary mining superintendent could not lay out work of that kind because some men are very good in carrying out work, but they do not know at all what kind 4208
of equipment they need. I saw that work while it was in progress,

as I went up there I presume every six months. There were no other shafts sunk or tunnels driven under my direction. My headquarters during those five years was in Los Angeles. I did not do any civil engineering work during those five years, other than I have detailed to you.

The outfall sewer that I constructed in Los Angeles ran along the line across the drainage, and did not follow the natural line of drainage which would have gone on the Biona Slough for the purpose of utilizing the sewage for irrigation. I used two inverted syphons to accomplish that purpose, and these reached about three miles in length, were constructed of wooden stave pipes, and were about 34 or 36 inches in diameter. That was to carry the water across the two depressions. Where I left the city I constructed a 40 inch brick conduit, I think about a mile and a half in length. At the end of that the first syphon began, and at the end of the first syphon I pierced a ridge by means of a tunnel a little over a mile long, and then also a 40 inch brick conduit; at the end of this mile tun-
4209 nel I started a second syphon which was about three miles long, and at the termination of the second syphon, the conduit was a 40 inch brick conduit, and continued as such until I got to two ridges of sand near the ocean, both of which were pierced by tunnels. The outlet end was a cast iron pipe of, I think, 24 inches in diameter, leading into the ocean. I prepared the specifications and the plans for that work, and they must be in Los Angeles. The work was done by contractors, who were, I think, John Redman, Joe Mansfield, Mackay & Long, Frick Bros., and August Meyer. The late P. J. Flynn was my advising engineer. He was the author of the celebrated hydraulic tables that were published by Van Nostrand. I outlined the plans, and Mr. Flynn checked me and advised me. I do not state that I did every bit of the work, but the general outline was mine.

4210 I advised Mr. S. Morgan Smith on the construction of a water plant for the King of Arizona Mine. The plant was not entirely designed by me. I was advised on it, and I said, "Go ahead, that's the thing to do". The proposition as first submitted to me was on specifications drawn up by an attorney, calling for the pumping through 60 miles of 2 inch pipe of water from the Colorado River over to that mine. The plan was submitted to me, and I advised to go ahead on it, and I think I had a great deal to do with passing on the plans, as I was the responsible party on that. The plant was
4211 built, and we had to shove 40,000 gallons a day into that mine, which we thought in that arid desert was a large quantity. We had to send the water about 7 miles through an ordinary standard 2 inch screw pipe. There were also three wells 1,080 feet deep, about 100 feet apart, and cased. At the head of each well there was a Cook Steam-head to lift the water out of the well into a tank about 6 or 8

feet in diameter, which was about four or five feet above the surface of the ground, and then this water flowed from this tank into a Worthington High-pressure Pump, which forced the water from the tank into the tanks at the mine. I determined, from computation, that a certain size pipe would do the work. 4212

I have built about 75 miles of sewer as City Engineer in Los Angeles. Those were built by contractors, but I prepared the plans and specifications and looked after the construction, and estimated the cost of doing the work. The records of those estimates are in the City of Los Angeles. Mr. Flynn was not with me at that time, he died I think in 1893. There are a great many miles of pavement laid by contractors, working under specifications drawn up by myself. We prepared all the assessment diagrams and plans upon which the money was subsequently collected. I did not have the supervision of any of that work. It was all under the Super- 4213
intendent of Streets, but my own engineers were always on the job, and I ascertained the cost of doing the work. I was responsible for it and I went out on the work. I certainly gave attention to the designing of it. There was not a design made that I was not consulted on; it could not pass unless it received my approval. I made the designs for two big tunnels in Los Angeles. One was the Third Street Tunnel, which was built by my successor, and the other is 4214
the Broadway Tunnel, also built by my successor. The plans were prepared by me in compliance with a Council Order requesting plans and specifications. My successor might have modified my plans, but the general form of construction, as I understand it, was substantially complied with as designed by me. I do not know definitely that my successor followed my plans at all, but as I can see it the work was carried out pretty nearly the same as it was designed by me.

The storm sewers that were built in Los Angeles were planned 4215
by me, and were built under contract. They were small storm drains, probably three feet in diameter, and I had direct supervision of some of them. We would build them out of cement pipe, and I had charge of making the pipe even. There were flumes built on the irrigation systems in Los Angeles, but they are probably all taken out now, because what was then irrigated land has all been taken up since, and cut up into city lots.

I designed an earthen dam for the proposed waterworks of Los Angeles in the ravine in which the Buena Vista Street Reservoir is located. Mr. Mulholland built a dam at that point, but whether he built it as designed by me, I do not know, although he built a general earth dam, which was the design I had laid out for that spot. I do not mean to say that Mr. Mulholland adopted my work, but 4216
I designed an earthen dam pretty near the site where Mr. Mulholland built an earthen dam. I designed several dams for the proposed

water supply, but I think that is the only one that was ever built on any of the sites for which my plans called for a dam.

I laid some cast iron and sheet steel water pipe in Los Angeles. There was a cast iron pipe which I used to cross for a crossing of a 30 inch sewer across the bed of the Los Angeles River. I should say that section did not exceed 400 feet long. I laid that section. The pipe was between 24 and 30 inches in diameter. It joined the iron,
4217 stone or earthenware pipes, and although it was a sewer pipe, it had to be laid just as carefully as a water pipe. The sheet steel pipe I laid from Reservoir No. 4 to Westlake Park, and my recollection is it would be about a mile long, and I think the size of the pipe was about 12 inch. It may have been sheet iron, but I am inclined to believe it was sheet steel pipe. It was manufactured by a local pipe works. I drew up the plans and specifications, located the line, and described the depth at which the pipe was to be laid, and it was built in accordance with my plans, and to my satisfaction before the work was paid for by the City. It was laid in the streets in an open trench, which was subsequently covered over, and my impression is it was a slip-joint. I think 50 lbs. would be the maximum pressure at the lowest point which that pipe was built to withstand.

4218 The Westlake Park pipe may have been a steel pipe, I do not remember. Sheet iron and sheet steel are practically synonymous as we ordinarily use them. My impression is that this was steel, but
4219 as to the length of it, I am not certain. Whatever the distance, it ran between Reservoir No. 4 and Westlake Park. Steel pipe and iron pipe cost about the same to fabricate; that is to roll the plate, to chip it, to calk it, and put it in place, and of the two, steel is the cheaper. The ability to value a plant of this nature requires more or less knowledge of iron pipe. Aside from the iron pipe which is in this system, I have had nothing to do with the purchase, laying, or the examination of stone pipe other than in the instances I cited to you relative to that pipe which I had laid in the City of Los Angeles. That was the plate iron or sheet steel pipe. The ability
4220 to value a plant of this kind should include a general knowledge of iron pipe, its cost, and the methods of manufacturing it. Plate iron pipe is manufactured as follows: The ordinary iron is taken and rolled into strips of the required thickness and size, and is turned out in plate steel. There comes a time when I don't believe the highest trained specialist can detect the difference between iron and steel. All iron plate is not puddled. The ordinary wrought iron of commerce is a puddled iron, and that is what makes it so scarce. It is supposed to be the purest iron. The iron, after it comes out of the furnace is pig iron, and then it is given subsequent treatment. Puddled iron is the old style method when you handle the iron by hand labor, and a man would have a big ball of it. I

have never seen iron actually handled in rolling mills, but I have, from general reading, gotten an idea of how it is treated. Charcoal 4221
iron is where charcoal is the fuel employed in getting a superior grade of iron. I am not sufficiently posted to determine whether charcoal iron and puddled iron is the same thing, but I know that you can get a charcoal iron that is puddled. I am not up on the technique of manufacturing iron, and as an engineer it would not be necessary for me to know the actual technique of the fabrication. I could adopt the standard specifications which have produced certain results in other pieces of work and accept that. Puddled iron and charcoal iron may be both the same, but charcoal iron is supposed to be a superior grade, and there is very little of it made nowadays. The great majority of iron plate is steel plate. Some firms make pipe of what they call pure iron, but there are not many. Steel is being used instead of iron because it is cheaper, and where 4221½
you can protect it by a coating and keep it away from moisture, it answers its purpose very well. Steel is also stronger, and the tensile 4222
strength of it is greater, and it can be obtained more readily. Steel was first used for pipe about 1890. I have never bought any wrought iron pipe, with the exception of 1,000 feet or so, which was only 2 or 3 inch pipe.

You can form a pretty good idea of the price of the wrought iron pipe of the Spring Valley Water Co. at the time it was laid; "The Iron Trade Review" publishes a diagram giving the price of various classes of material, and from that you can come pretty close to ascertaining. I have copies of the specifications of the iron pipe 4223
that was put in by the Spring Valley, and the market quotations would enable me to determine what was the proper cost of the iron of those specifications. These market quotations run back say as far as 1884. I do not mean to say that I can get quotations now on that kind of iron, but there are publications of trade journals giving you the prices prevailing, and if you let 20 years go by, that data of today is data you can use 20 years hence to ascertain prices today. You are getting prices on the same kind of material. Your pig bears a certain relation to your manufactured product, and the various diagrams which are printed by the trade journals show almost a constant relation between the basic price of pig and the various products, so that with the aid of these diagrams, you can get a fair idea. I assumed that part of the iron in these pipes of the Spring 4224
Valley Co. was charcoal. I figured on these pipes in accordance with the specifications which I had from the company's records themselves. I think in conversation with Mr. Schussler, he told me he used a plate of charcoal iron, upon which he piled scrap, and then on the top placed a plate of charcoal iron, wrapped it all, put it in the furnace, and when heated to a proper degree it was put through the rolls.

4225 With the exception of a piece of pipe line in Los Angeles; the short piece of cast iron pipe as part of a sewer, and the six miles of wood stave pipe, I have never laid any pipe. I have never constructed any part of any existing water works system, and I cannot recall the construction of any part of what was a water works system, but which has ceased to exist. I have never made any pipe, but I have prepared specifications—the Los Angeles case—for the making of pipe. I do not think that there was ever constructed under my supervision or direction any element of a water works plant other than the items I mentioned. I have never directly had anything to do with the operation of a water works system. When
4226 I was City Engineer of Los Angeles, the water plant was privately owned.

A person in order to express a reliable opinion upon the value of an existing water works system should have as much knowledge as he can possibly get hold of through the records of the company, his own observation of the company's workings, and the records of other properties. Those two requirements might be met by anybody not a civil engineer. For an engineer to place a value upon a water plant, he ought to have a knowledge of the cost of operating a plant, and the cost of the doing the work, constructing it. He can get that knowledge if he knows how to analyze work, and ob-
4227 serves the cost of doing work. An engineer to get his knowledge must have besides a technical education, judgment, observation, or experience. I think a man would be qualified to express an opinion with reference to the value of a property as extensive as this is, who
4228 has had no experience in the construction of such property. If he had a knowledge of the records of the company; say that he had read through the minutes of that company from the year one down to the present date, that he had read the reports that that company had made to the authorities who had the fixing of that company's rates; that he had read the reports of the officers of the company as to the costs of doing the work; that he has had examined every item charged to operating expenses; that he has gone over the records; that he has a working knowledge of how the plant was operated, and knew the physical lay of the ground; that he not only knew the cost of that company's doing work, but the cost of any company's doing work in the bay region, and the cost of doing similar work by able engineers along the same line; that he had read up the general principle underlying valuations, and followed court decisions. If he had done that, he would ordinarily, as an ordinarily qualified man, be competent in my opinion to pass upon and give his idea of the value of the property. I think he ought to know the application of the principles of civil engineering sufficiently to apply them to the problems in question. He has to apply the information he gets from his access to the books, to his judgment, and applying

that, would be the element he would gain through his experience as 4229
a civil engineer, if he had done some construction, and was able to analyze costs. A man could put in the books that so and so cost so much money, and the man analyzing the costs must have that God-given sense that enables him by an inspection of the property to say that that could not have cost that.

If an engineer has not had access to the books, to enable him to put a valuation upon this plant, he has to know what it is designed for, how it is operated, and the cost of operating it. He must know the cost of doing work, and the cost of material, and if he has not had the experience himself, it must be from observing the experience of other men who are doing practically similar work. He may not have done the work, but he may have observed the cost of doing it, and be able to analyze it, and be a surer guide than the man who has done it. I do not think it is necessarily important that 4230
an engineer placing a value on a plant of this kind should have done any work of the nature of that involved in the construction of the plant, if he has observed and knows the cost of doing similar work, and has the ability to analyze and to segregate between the cost of material and labor, and the overhead charges, such a man with a knowledge of a very limited piece of construction is more safe to estimate on the cost of work than a man who has done a whole lot of work, and who has never kept track of doing it, and did not know whether he was making money or losing it on a particular piece of work.

Outside of the outfall sewer, and the work around the city, we ascertained overhead charges because we had to submit them with the work done. I do not know the percentage of overhead charges that we allowed; it was the actual expense incurred in each case. Overhead charges may not have been specifically entered as overhead charges, but as a percentage I added enough to cover them, and the proof is that I built the work within my estimate. I made an allowance for overhead in 1897, but I do not remember what I 4231
called it, or what the allowance was. Where I have not had direct charge, I cannot tell what the overhead is on a plant of this kind, when you exclude the most valuable line I have got—observation and the results of others. By observation I mean going by the records. There is a big difference between asking a man for information, and asking him to show it to you in writing. He may, as a result of asking him, forget some points; when it is in writing he has included everything. If I exclude the information which I derived by examining the records of corporations, I have no knowledge whatever of the question of overhead, other than the Los Angeles experiences. I have never done any work of any kind personally, 4232
except these small pieces of work in Los Angeles, 18 or 20 years ago, that will enable me to determine what the proper allowance for

overhead is. I had a little overhead on the reclamation work at the Orphan Asylum, which was 10% I think.

4233 I am conversant with the cost of doing the work on the east side of the bay, which is similar to the work involved in the construction of the Spring Valley plant, but I got that information from the records, and if you exclude records, I have no knowledge about the cost of doing work similar to the work involved in the construction of the Spring Valley plant. Cost has to be carried on a record, and I got it from the company's office, their vouchers and bills they paid. If I didn't have any knowledge of that sort, I would be handicapped in determining the cost of reproducing this property. I might make an estimate of it, but I would not have that ground of surety which I now possess in handling the subject.

A man would read proceedings. I read nearly all the testimony in the condemnation under the Metropolis Water Act of 1902, of the eight water companies which the City of London took over. If Mr. Hazen had never read that record, I would not think that a reflection upon his ability as an expert to value this property. I regard it as a qualification of an engineer to have read that testi-

4234 mony, and it is one of the points in my favor. If his Honor had read it, it would not make him an engineer, but it would give him a broader range of knowledge as to that particular subject. I read the Newburyport case, and the Gloucester case in which Mr. Hazen testified, as I wanted to find out what points were adduced, what was the nature and the method of preparing data, and as to what were the theories and rules of law that governed. I read it in the general investigation of the subject. I read the testimony in the Spot Pond case, in which the cities of Morgan, Medford, and Melrose were involved, having Spot Pond as a source of water supply. Those were famous cases, and I sent for the record and tried to read

4235 up and be posted on them. I read up all the testimony before the Board of Supervisors of the City of San Francisco, by the Spring Valley Water Co. from the year one. I read up every record that I could get hold of to throw light on the subject. The principles on valuation have only come in lately, and you will find in 1904 there was very little of it extant in the way of literature. An engineer would read up the books published on the subject by the American Civil Engineers, and he would read the decisions of the Supreme

4236 Court of the United States on rate fixing, because that gives a pretty well defined idea as to what the Court expects shall be investigated in the ascertainment of the value of the property. He would read standard authors, and on valuation he might in the late years read Whitten; he would read Foster. He would read the books that

4237 describe the water works, and he would go over those works himself. He would practically make a book by going over the works himself, and he might read what articles there are descriptive of the works.

The first author I remember reading was Fanning, the first volume of which I bought in 1887, I think. Then there is Tourneau; and then there is Russell, who wrote on water supply. I read their works. I think I have read the publications of Mr. Hazen, and I have read as fast as they have come out nearly all the publications on water supply. A man reads those papers, written by prominent engineers, to post himself as to what has been done, for if a man is 4238
working only in one town, he will never know what is going on in another town, unless he reads about it or hears about it in some way, or sees it. I have not done any work, other than what I have stated, for the past 17 or 18 years, but I have been a pretty fair observer. Whatever I would write would have to be written from the standpoint of experience I have had just as an observer.

SIXTY-FIRST HEARING. NOVEMBER 16, 1915.

Witnesses: J. H. Dockweiler, for Defendant,
Geo. L. Dillman, for Defendant,
W. B. Lawrence, for Plaintiff,
Allen Hazen, for Plaintiff.

4239

(Certain corrections noted on the face of the record).

CROSS EXAMINATION BY MR. MCCUTCHEN. 4240

It is my opinion that a technical education of itself is not sufficient to qualify an engineer to value a water works property such as the one that is to be valued here. It should be supplemented by observation; reading literature bearing on appraisals, and reading over the records of appraisals; a person should have a knowledge of the cost of constructing works, and in addition a very intimate knowledge of the property in question; he should ascertain as much as possible what its history has been. The knowledge of the cost of constructing works is obtained either by actual experience or by observation, and if one starts with a technical education, and has had actual experience, it may be necessary for him to read literature in order to determine how a plant should be valued, as he may not have had experience in appraisal work. There is a marked difference between appraisal work, and construction and designing. A man may have built works, but it does not follow that he knows the cost, as he may not have the power of analysis. A man is better qualified if he has read appraisal 4241
reports made by others, for in my opinion it is necessary in appraisals to ascertain the original cost of the property in addition to the cost of reproducing it at the present time. He must know something of the theories of depreciation and how to apply them. He must know

something of the average life of structures, and he can get that only from reading up on the subject, because a man will not have within the range of his absolute own experience knowledge to tell him how long a structure will last. I do not think there is any man living who has laid a large amount of cast iron pipe, who can tell of his own experience how long that pipe is going to last.

If a man starts with a technical education, and supplements that by extensive experience in designing and construction, but has never read any appraisals made by anybody else, I think he labors under a
4242 disadvantage in making an appraisal of a given property. The Los Angeles water works was the first works I appraised, and I had the advantage of local knowledge, as I had seen those works built and had grown up with them. I had been over them many times, and knew the history of them. I have gained in knowledge and experience since then, but the fact that the Board of Arbitration found $5,000 less than in my appraisal, practically sustained my work. That had some point in qualifying me as a valuer of public service properties, and I think that the test of experience justified me in assuming that that qualified me to make subsequent appraisals. The experience had in examining the books of corporations is an education in that line, and
4243 a man's experience and learning all go to make and round him up.

Experience, coupled with observation and analysis, count for a very large percentage. I know contractors who actually go broke on some work because they have not the power of analysis. My system was to make an analysis of the work in a proper way. The reputation of an engineer is established by honesty, industry, application, a study of the problems, and percentage of common sense, powers of
4244 observation, a willingness to learn, talking with and conferring with others, and having the ability to pick out the points. He may not be able to originate a point, but when it is brought to his attention he can see its advantages and benefit. An engineer gains a standing among his fellows through his knowledge, experience, and honesty, and the fact that he has done something. I do not know of any man in the engineering profession who stands particularly high with his fellows who has not done something, and if he had not designed and constructed works, he would not have much standing with his fellows in that particular line. As a general rule the men of a profession are the best judges of the ability of the members of that profession, and their ability is ordinarily tested by what they have done. If an engineer had read all of the appraisals that were ever made, and had done nothing more, it would not commend him very strongly to me as an hydraulic engineer. The fact that he had made appraisals, even if they were not based upon experience in designing and construction, would not necessarily not commend him to me, as he may not have had the actual charge of the designing of work, and yet he may be
4245 able to study it up and analyze it.

I have inspected the work that was being done by the Contra Costa Water Co., although I was not on that work all the time, but just sufficiently to keep posted as to what was going on. I had available the records, payrolls, and all the office memoranda that the company made, and by going out occasionally it gave me an idea of what was being done; I ascertained the cost from the bills the company paid. I could have gotten all that from the company's records, but having knowledge of the work, it didn't take me so long a time to co-ordinate them as it otherwise would have. My information was simply to aid me in co-ordinating those figures, and showed me the manner 4246
in which the work was being done, and the methods employed. I make it a rule to observe work wherever chance happens to find me, and I have inspected and watched very closely the laying of the large plate iron pipes in the City of Los Angeles. I have made various trips to Los Angeles since I left there. I have been on the work of the Los Angeles Aqueduct on an average of three times a year during its entire construction, and put in a day and a half or two days on each occasion. I spent, roughly, about 25 days on that work. I ex- 4247
amined a tunnel with Mr. Mulholland in Los Angeles. I have gone to the various pumping stations, some of which were in course of construction at the time. I went out and noted where they were driving wells. I would note in San Francisco a job of pouring concrete on a building; I would note work being done on the streets here, and wherever there was a trench open, I would examine it to see the nature of the soil, and especially the character and condition of the pipe that was being uncovered or laid. I have noted that with reference to the pipe of this company, of the gas company, and telephone conduits. I have noted the work being done by the street car companies. Any time I have seen a sewer trench open, I would stop and examine it and try and note things. I was along the City's high pressure fire system many times, and took in their reservoirs. Taking a period 4248
of practically six years over in Oakland, I presume it would be fair to state that I was out one day in each week on an average, looking at work of one kind or another. I went out and looked at it just as any other engineer would do as a matter of curiosity and knowledge. I think every engineer is interested in seeing work done, as to methods and so forth, as he is anxious to keep up with the improvements. Wherever I have been in a city I have tried to look at the engineering work and get in touch with the men. I have been in the City of San Diego, and have examined the pumping stations that were building, and the wells recently installed, and how the water was gathered into a central basin, examined the distributing reservoirs, noted the vari- 4249
ous ways employed in laying pipe, and had explained to me why certain things were being done. On a trip east I had Mr. Hazen show me the great Washington filtration plant which he had designed and built. I examined the filtration plant in the City of Philadelphia.

In the City of Boston I was shown over their works, and I went out to the large Wachusett Dam, and was shown over that territory by the engineer in charge. I am personally acquainted with some of the
4250 men there; Mr. Desmond Fitzgerald, Mr. Frederick Stearns, and Mr. Dexter Brackett, who were connected with that work. I read about the New York water supply, and the great plans for the Catskill project; I was shown over those works by the chief engineer.

They were building the Kensico Dam when I was there. I noted how they were handling the material, how their plant was laid out, and so on. On that trip I was there only one day.

My impression is that I have seen wooden telephone conduits on Market Street, and I looked at them to see how they showed up as a result of having laid in the ground for years. The pipe leading to
4251 Westlake Park, Los Angeles, which I laid, was for the purpose of irrigating water to supply the lake in Westlake Park. That was under pressure, and the pipe lines followed the grades of the street just a few feet below the surface. It was a plate iron pipe, slip joint, and I think 50 lbs. would be the maximum outside pressure that it would have to withstand.

4252 I recollect having made an affidavit, which the City Attorney's Office intended to use on a motion for an order for an inspection of the books of the Spring Valley Water Co., but I do not remember that I stated therein that I was employed to give testimony favorable to the defendant in this action. (Counsel for Defendant advised that he drew the affidavit, himself, and the language was that the witness was employed to give testimony on behalf of the Defendant in this case).

RE-DIRECT EXAMINATION BY MR. SEARLS.

4253 I am a member of the American Society of Civil Engineers; of the Pacific Coast Association of Consulting Engineers; the local branch of the American Society; the Engineers' and Architects' Association of Southern California; of the American Waterworks Association, and of the New England Waterworks Association.

In my opinion a valuation engineer who has had his appraisals repeatedly subjected to cross-examination, and the test of judicial interpretation, can be just as well qualified to credibly inform a court, as a man who has constructed a great deal of work, but has not kept records of what he has done, because I believe a specialist in a line is better qualified than a man not a specialist.

A pamphlet entitled, "Twelve Years of Professional Work" in-
4253-4 troduced and marked "Defendant's Exhibit 95".

RE-CROSS EXAMINATION BY MR. MCCUTCHEN.

A man who has made designs and carried on the construction, and has also kept accurate record, has an advantage over the man who has not made designs and carried on construction.

Witness: GEO. L. DILLMAN for Defendant.

DIRECT EXAMINATION BY MR. SEARLS.

I am 55 years of age, reside in Alameda, and have been a civil engineer for 32 years. I graduated from the United States Naval 4255
Academy in 1880; began engineering work in 1883 with Chicago, Northwestern & Dakota, railroad construction and surveying. Then went to La Crosse, Wis., and was an assistant engineer on the La Crosse & Onalaska Railroad construction until completed. Went from there to Nebraska on the Burlington & Missouri River Railroad in Nebraska. I was on the construction of the De Witt & Western as instrument and estimate man. I went on location as topographer, draftsman and instrument man. From there I went to Illinois on the Chicago, Burlington & Northern construction. I was with that company practically four years.

I went to the Union Pacific in the fall of 1886, and was with them on construction work four or five years. I went to Pecos, N. M., in charge of the contractors' force on the Pecos Canal. After that work I was contractor's engineer on the Bob Creek Canal, in Colorado, and various other small canals of Pueblo. The Union Pacific went into the hands of a receiver in 1890 or 1891, and I became manager of construction of the Portland Construction Co., and built some work under contract in the vicinity of Portland. I came to California in 1892 4256
to manage the contractor's outfit on the Poso Irrigation Works in Kern County. In 1893 and 1894 I built the Rio Bravo Canals in Kern County. I built several bridges in Kern County, and made investigations, surveys and plans for an irrigation plant from the North Tule River for an Omaha syndicate.

For the Union Pacific I had charge of location, construction, and purchase of right of way, developing various water supplies for railroad purposes, the biggest one being the Hanna & Dana Pipe Line, in Wyoming, afterwards constructed along my lines. From 1896 to 1903 was consulting hydraulic engineer for the Willamette Pulp & Paper Co. I was engineer for the Contra Costa Water Co. for a year or so, during which time I constructed two pumping plants, wells and pipe lines. In 1898 I investigated and testified for the Portland Water Commission, in the sliding land case which arose in the Parks. During that time I became somewhat familiar with the Portland water works. I took the first contract that was let by the Portland Water Commission for clearing their right of way to Bull Run, but I had nothing to do with the construction. About 1900 I superintended a contractor's force on the Astoria & Columbia River Rail- 4257
road until that road was finished; afterwards had similar employment on the Nevada Northern, and have done some work on the Oregon Railway & Navigation Co.'s lines.

In 1896 I became consulting engineer for the San Lorenzo Water Co., and have been in their employ ever since. I recently made a

valuation of their plant before the Railroad Commission for a permit to sell the property. I made an appraisal of the Berkeley plant of the Contra Costa Water Co., and after the consolidation of the Contra Costa with the Oakland Water Co., I made an appraisal of the whole plant for that company. In 1902 was appointed State Engineer for Oregon to examine the proposed reclamations under the Carey Act. In 1903 became Chief Engineer of the Western Pacific, and remained in that capacity and supervising engineer for three years. Have been consulted about various reclamations in the State, including Jersey Island, Bouldin Island, the Natomas Consolidated, for which latter company I made surveys, estimates and plans for the original reclamation. About 1896 I designed a dam for the Stanislaus River, and my partner, J. B. Wallace, supervised the construction of it. I made estimates of the value of the Livermore water plant for a purchase by W. A. Bissell, and afterwards the same plant for the Railroad Commission in the transfer of the property to the Pacific Gas &
4258 Electric Co.

I have installed air lift plants for the San Lorenzo Water Co., at Mt. Eden, the Contra Costa Water Co., at Alvarado, and water works at Heppner, Ore.; for San Lorenzo, Oakland, and for well testing purposes at Oakdale, Stanislaus County, and at Sebastopol. In 1910 I undertook the work of the Oakdale Irrigation District, and carried the work up to the supplying of a large percentage of the lands with water. I am consulting engineer for the Sutter-Butte Canal Co., at Gridley. While at Oakdale, about 1912, I built new waterworks and sewer plant for the city, including the development of a new supply, and a duplicate pumping plant, complete pipe lines, and storage. In 1904 the Ocean Shore Railroad Co. consulted me about three difficult points of construction, and two of these alleged impossibilities were solved under my direction. The third is in the gap between the two ends of the line now.

I think I am familiar with the cost of materials and labor in the West, and am familiar with the cost of the machinery necessary for such work. My acquaintance with machinery, and my ability to estimate it, has not been to a test in these estimates, because I have made no estimate of the pumping plants in the City of San Fran-
4259 cisco for lack of time.

The riveted pipe was first built and developed on the Pacific Coast, and until very recently we had a remarkable series of dams on the Pacific Coast. There have been two masonry dams constructed higher than our masonry dams, and one earth dam constructed higher than our earthen dam, so that we have not the highest masonry and earth dam in California, though we did have until quite recently. The highest earth dam for many years was at San Leandro, known as San Leandro or Chabot Dam, and the highest masonry dam was the Crystal Springs Dam of the Spring Valley Water Co. Until the construction

of the Gatun Locks, that was the greatest single block of concrete on earth. The highest overflow dam in the world is the La Grange Dam, on the Tuolumne River. The thinnest dam for its height was the original Bear Valley Dam, in San Bernardino County. The overfall dam passing the greatest amount of water at flood times is the intake dam of the Great Western Power Co., on the Feather River. In California we did the first submarine blasting that was effective in the world. We patented and perfected and made a working possibility of the suction dredge. 4260

In an appraisal of works of that type, after they are constructed, a man would be better qualified if he were acquainted with the peculiar type of construction that was involved there.

At the request of the City Attorney's Office I made an appraisal of the structural properties of the Spring Valley Water Co., and I shall in my final appraisement accept the figures of Mr. E. P. Jones in the matter of machinery and pumping plant inside the city, with the exception of those figures, the appraisal will be completed by myself. I commenced that appraisal in June or July of last year, I think, and spent about six months altogether in its preparation, and this year. In its preparation I familiarized myself with the construction of the Spring Valley Water Co. to the extent that I considered it essential. I have been over those structures and know the plants; I know the location of the pipe lines and the other conduits. I inspected the Crystal Springs construction when it was being constructed. I am somewhat familiar with the Contra Costa plant; some- 4261
what less familiar with the Portland water plant. I am entirely familiar with the Haywards plant, the Livermore plant, the Oakdale plant, the Sebastopol plant.

CROSS EXAMINATION BY MR. McCUTCHEN.

The Rio Bravo Canals in Kern County are the canals of the Rio Bravo Ranch, and belong to Henry Pierce. They are used entirely in the irrigation of parts of the Rio Bravo Ranch, and are rather small, being probably 4 or 5 feet wide, and carry 2 feet of water.

The Poso Irrigation scheme was never completed, and my connection with it was very brief. About $50,000 worth of work was done before I came to California to manage that contract. Finances were in bad shape, and about all I did was to knock off work and wait for finances to better themselves, and in 1893 I sold them out with about enough to pay the debts of the concern. We never got paid for that work at all. It was a complete loss. The Poso District was organized under the Wright Law to irrigate some 40,000 acres of land. The water supply was insufficient, as were the funds; the work 4262
has never been completed, and should have never been started. It was a very large irrigating canal, and was built through as bare a

desert as there is in the United States. It was scraper work; there was immediately adjacent a rock-filled dam which was built out of a bluff of limestone, and I think that has gone out three times since they built it and rebuilt it. I had nothing to do with that.

I made plans for the laying of the Hanna & Dana Pipe Line, which began at a creek up on the side of Elk Mountain, in Wyoming, and ended as a single pipe line toward these two coal towns, and
4263 divided there, furnishing a water supply to each place. At that same time I was building what was known as the Car Barn Cut-off, branching from the Union Pacific at the Allen Junction, and went to the Dana Coal Mines. I think it was about 20 miles long, and is a part of the reconstructed Union Pacific now. The Hanna & Dana pipes were about a 10 inch line. I did not put the pipe in, but Tommy Witch, who was Chief Engineer of the Western Pacific, followed me there, and told me that the pipe line was built along the lines I laid out. Mine was a detailed survey, and it included a dam at the intake, a survey for the pipe line, and an estimate of the cost. I do not think I wrote up any specifications.

I studied the conditions at Oregon City principally for the Willamette Pulp & Paper Co. They had a power plant, and the condition at the crest of the falls was very unsatisfactory. There was a
4264 division of power rights there, and they did not know just where their rights were, or what was best to do to better their conditions. I studied their conditions through two or three seasons before I was satisfied that I knew what their trouble was, and what would rectify it. After that it was rectified, and it is all right today. The rectification consisted largely in changing the crest of the weir at the falls, and raising that a foot; that obviated all the trouble, and didn't get into any difficulty by reason of backing up the floods so much. I did some construction, put in some machinery, and rebuilt a large power flume which was 60 feet wide, 100 and some odd feet long, and carried 20 feet of water in vertical depth. I rebuilt the whole flume with concrete, and worked out a very nice little problem there. That com-
4265 pany used all the current they generated on their own premises. I would go to the plant three or four times a year for a week or ten days at a time, excepting 1901 or 1902; then I spent an entire summer there doing this construction work.

The year I was engineer for the Contra Costa Water Co., which was I think in 1899, I built the Glue Factory plant, and I put in a
4266 pump on Cemetery Creek in Oakland. I was not the general engineer of the company, but was employed for this special work. Orestes Pierce did most of the work. Mr. Boardman was not the engineer at that time.

I became consulting engineer for the San Lorenzo Water Co. in 1896, which was owned by the Pierces, and supplied the town of San Lorenzo. It got its supply from wells driven in the marsh.

After the consolidation of the Contra Costa & Oakland Water Companies I made an appraisal of the whole plant for that company. The Contra Costa Co. was the company that owned the consolidated property.

While State Engineer of Oregon, I examined all the applications under the Carey Land Act, and made recommendations to the State Land Board, and in that way I visited Eastern Oregon, and got pretty well acquainted with that country, and with the proposed irrigation problems. My work was approving the withdrawal of United States 4267
land for the benefit of these Carey irrigationists. It was arid land. They received applications, and got to a certain point; then they did not know whether they were right or wrong, and wanted somebody outside the State to act as State Engineer, because the prominent engineers of Oregon were connected with one or more of these different projects. As State Engineer I did not prepare any plans for reclamation, but I went over the plans prepared by others.

I was consulted about various reclamations in this State, including Jersey and Bouldin Islands with reference to levees and interior drainage which was gotten rid of by pumps. For the Natomas Consolidated I made the original plans for the reclamation of the American Basin, which have been carried into effect since, with some modifications. 4268

The dam designed for the Stanislaus Project was a low diverting dam, at Six Mile Bar on the Stanislaus River, and its purpose was to divert water into the old canal. It was afterwards known as the Tullock Project, and was so known at that time. It was originally an old mining diversion, and was taken up in 1902 or 1903 by Ledbetter, and then was sold to Mr. Tullock and his associates, the Lanes, and it was during their ownership that this dam was built. It is a masonry dam, about 20 feet in the highest part, and about 300 feet long. I had nothing to do with that work.

I made an appraisal of the property of the Livermore Water Co., which was not much in detail, but was sufficient for the purpose, and 4269
was accepted by the Railroad Commission. The plant installed at Oakdale was an air lift plant to test some new wells that I had dug. It was a very simple construction.

The Oakdale Irrigation District had not begun the construction of its work before my employment. The first issue of bonds, I think, was voted in July, and my work commenced in November or December of 1910, and consisted of canals on both sides of the Stanislaus River, and main canals, and a distribution system through the lands to be irrigated. That was scraper work in yardage, but not in cost. There was more earth yardage than rock, but there was more rock costs than earth. There were a couple of small dams that I built, and another dam which Mr. Edwin Duryea, Jr., had charge of the construction of. The ones I built were concrete dams; just a buttress

wall; one in Little John Creek, and one in a branch of Dry Creek.
4270 The canal got water from the Stanislaus River, which was diverted into the canal by the large dam that Mr. Duryea built. The sizes of these dams that I built were, the highest one 13 feet, and about 250 or 300 feet long; and the other about the same, but shorter. I drew the plans for those dams, and the work was performed under my supervision. There were also 17 or 18 tunnels, one of which was 7,000 feet long, and we drove it in three months and a half. A portion of
4271 the big tunnel, and two of the smaller ones were timber lined; I think they are now being concrete lined. The next largest tunnel, I think, was about 3,000 feet in length.

I laid a complete system of pipes at Oakdale. I laid pipes from the Glue Factory to San Leandro for the Contra Costa Co., which I
4272 think was 18 inch or possibly 20 inch pipe. The water was delivered into the mains of the company at San Leandro; part of it went to the lake, and part of it was distributed to San Leandro. The pump at Alvarado lifted that water up. That pipe line was installed either in 1898 or 1899, sometime before the consolidation of the Contra Costa and the Oakland Water Co. From memory, it must be 13 or 14 miles long. I presume I laid altogether 12 or 14 miles of pipe at Oakdale, the largest of which was 12 inch, and took up about a mile of the entire amount. The source of supply was wells. I do not think I have been in direct responsible charge of the laying of much other pipe, and I do not think I have dug through a pavement to lay pipe. I
4273 have laid pipe in a street with other pipes at Oakdale. Some of the other pipes were in use, and some of them were abandoned. They were old water pipes. I installed this plant for the City of Oakdale.

The construction of the flume at Oregon City was probably the biggest piece of dam construction that I have done. I have never built a large earthen dam; there were some small earthen dams in connection with the various projects that I have been on, but they were hardly high enough to be called dams. I have been practicing my profession 32 years, and I think in a case of this kind it is a good plan for the engineers representing the respective parties to sit down and endeavor to agree upon reproduction cost, as I think we will get nearer the right result than could be obtained in an investigation
4274 of this kind under the rules of evidence. I suggested it to Mr. Steinhart when the condemnation case was thought of, and I talked it over with Mr. Hazen. I think that we coincided in that opinion.

Lawrence Witness: W. B. LAWRENCE for Plaintiff.

4275 DIRECT EXAMINATION BY MR. GREENE.

I am 49 years of age, and am superintendent of the water division of the Spring Valley Water Co. I have held that position since

1908. Prior to that time I was one of the assistant engineers of the water company, and clerk for my father, who was general superintendent. That was between 1885 and 1888. My duties are the general supervision and operation, and repair and maintenance of the plant. They also comprise the care of the reservoirs, pumping plants, roads, fences, flumes, pipe lines, and telephone lines. My first connection with the company was in 1882 or 1883 for a period of two months on the preliminary survey of the Crystal Springs Pipe Line. I was rodman at that time.

Witness: ALLEN HAZEN, for Plaintiff. Hazen

DIRECT EXAMINATION BY MR. GREENE. 4276

The plant of the company comprises works for collecting and storing water in Alameda County and on the peninsula, the pipes and pumps for transporting it to the city, and distributing reservoirs, and the distribution pipes connected with them to carry the water throughout the city; the services, meters, roads, fences, stock and material on hand, and all of the properties that are necessary to prosecute the business.

The quality of the water is good. I have not made any special study of it for this case; some of the water is harder, and some is softer; that is a peculiarity with the general conditions of the neighborhood, and the water is as soft as could be supplied from the geological conditions that exist in this place. It is well protected from pollution, and the supply is an unusually good one in that respect. There is a little trouble at times from the growth of certain organisms in the open reservoirs, which get into the distribution system, and have caused at times in the past a little annoyance; that is a secondary matter, and the company has done all that it could have been expected to do in taking care of these matters up to the present time. 4277

The requirement of long storage in the distribution reservoirs plays a part in the presence of the organisms. The very long storage is in the impounding reservoirs away from the city. The reservoirs in the city serve the purpose of balancing the fluctuations from hour to hour through the day, so that the peak loads can be carried, and also to furnish a reserve in case of a bad fire or interruption of the supply by breakage of the main lines. Approximately half of the water now used comes from the peninsula source, and half from the Alameda source. More water will come from the Calaveras Reservoir. Calaveras water comes by Sunol at the present time, and some of it is used, but the Calaveras Reservoir will store the flood flows that now go to waste, and make them available for use throughout the year. The reservoir is large enough to make them available for some years afterwards in dry years when the winter rains are not up to the average.

4278 There are quite a number of services classified primarily as to elevation. The La Honda service—about 370 feet—is the largest and most important from point of output; University Mound would come next, being the lowest, somewhere around 150 feet; College Hill comes next, and is intermediate in level between the University Mound and La Honda. Those are the three larger services, and in addition there are quite a number of high service districts, and as the system develops, there will have to be several additional high service districts.

Ten years ago I should say, not from personal familiarity with the property at that time, but from my study of the structures and records, the service was thoroughly adequate in every respect. At the present time the plant is hardly up to the reasonable requirements of the service, as the additions to the plant have not kept pace with the increase in business and population in the ten year period past, and at the present time the plant is under-built to a substantial extent. A substantial investment would need to be made right off to bring the plant up to the reasonable requirements of the present time, and the service in the last year has suffered
4279 somewhat because of that. The suffering has been partly in reduced pressures and inadequate service where the distribution pipes were not large enough to carry the water required by increasing population, and the other part of the deficiency perhaps has not been felt, but it is just as real; the supply has been maintained for the last few years because the rainfall has been abundant. If this year and last year had been as dry as some previous years, there probably would have been an actual shortage of water; there should be more reserve capacity to provide against such contingencies, and while that shortage has not developed, due to the adequate rainfall, I feel that the plant has been deficient, and is deficient in that respect at the present time.

The reserve capacities I refer to are reserve capacities in storage reservoirs, with areas to fill them, and in the pipes to bring the water to the city, and all the works that are necessary to make the water available. The distribution system, and pipes to houses grow as the population grows, under normal conditions, but the supply units have to be added in large installments. It is not possible to build a tenth of the Calaveras Dam, and of the Calaveras Pipe Line in 1913 and put it in service. The only way that additions can be made is in fairly large blocks, each of which will ordinarily serve to meet the increase in consumption through a longer or shorter term of
4280 years. In my judgment the expenditures required to bring the plant up to present needs, and to provide for growth to be reasonably and conservatively anticipated in a ten year period will require an outlay of at least $12,000,000.

4281 Counsel for Plaintiff, Mr. McCutchen, identified the following photographs; these were received and marked in evidence with the

number it had received for identification: Exhibit 50 is a California laurel tree on the west side of the state highway, within 100 or 150 yards of the bridge over San Francisquito Creek, which is the dividing line between San Mateo and Santa Clara counties.

51 is a knoll in front of the F. W. Sharon residence, which lies westerly from Menlo Park.

52 was taken on the property of U. Porter, back of Los Altos.

53 was taken on the corner of John Oertli's land back of Los Altos, facing a little north of east.

54 is taken on the knoll in front of Sharon place, facing the Sharon residence.

55 was taken on top of a knoll on property of Dr. Shumate back of Los Altos, the camera facing north of east.

56 was taken opposite the H. D. Morton property at Los Altos, facing northeast.

57 was taken on a knoll east of the Percy Morgan place, at Los Altos, the camera facing north.

58 was taken on Purissima Avenue back of Los Altos, on the property of a man named Larrus.

59 was taken on the property of Morsehead, opposite the Portola Store, facing southeast.

60 was taken on the property belonging to the estate of F. G. Sanborn, at Los Altos.

61 was taken slightly to the northwest of the Hill Place, and near Professor Sloan's place at Los Altos, the camera facing north of east. 4282

62 was taken on the Morton Place at Los Altos, facing north of east.

63 was taken on a knoll south of C. A. Graves' residence at Los Altos, facing nearly north. On that property is a "For Sale" sign of the University Realty Co.

64 is on the property of the Leland Stanford University, and right back of the professors' houses.

65 is a knoll on the Burke property back of Los Altos, facing north.

66 is a knoll east of the Percy Morgan place at Los Altos, facing northeast.

67 was taken from Los Pulgas Ave., which is to the west of Menlo Park, facing southwest.

68 was taken just back of Los Altos, from a point just east of the property of the California Chicken Co., facing east and north.

69 was taken on Los Pulgas Avenue, near the property of Alexander Hamilton, facing southwest, west of Menlo, or west of Fair Oaks.

70 was taken on the Kohl property at Easton.

71 the same.

72 the camera was facing due west, and it was taken from a point about a mile east from Apperton Avenue in Menlo Heights.

73 was taken from the southern end of Upper Crystal Springs Lake.

4283 Counsel for Defendant agreed with Counsel for Plaintiff that the record in the testimony of Mr. Smith shows the sale price of the Husing land to Bourn at $125 an acre.

DIRECT EXAMINATION BY MR. GREENE.

4284 I do not think that an expenditure of $12,000,000 for further development was necessary during the years that are concerned in this litigation; in 1907 the system was pretty well built up to requirements. In the natural course of events an expenditure of perhaps a million dollars a year would have been made in extending the work. Actually it was not made, and the falling behind was gradual. Some money was spent, and some things were done temporarily that increased the capacity of parts of the system, and helped; the difference between a fully adequate system, and the system as it actually was gradually increased, until at the end of the period it was represented by quite a number of millions.

The design of the structures is good. I have never examined an old system of waterworks which showed such continuity of purposes as is shown by the works of this company. The metal was well arranged in the pipes; the riveting was good; the thicknesses were closely calculated, and were strong enough to do the required work,

4285 as is demonstrated by the very small number of breaks. The figuring was very close; the metal was stretched about as far as it was safe to go. The reservoirs and dams were well built, and the tunnels are of good workmanship. The distribution system is well designed and of good material. The works were laid out with a view to future development, and the whole system has been planned so that added units could be built and worked into the system as required. The number of structures which have been discarded during the years gone by I think is low. That has been due partly to the fact that the structures have been very durable ones, and in part to the fact that the design has been carefully arranged to anticipate growth, and to serve for a long period.

Questioned by Mr. Searls.

I am not familiar with the actual works that have been discarded, and my statement is based on information obtained principally from Mr. Sharon, but I have posted myself from every suitable source.

4286 DIRECT EXAMINATION BY MR. GREENE.

The works are capable of long future service, as they are for the most part, in very good order. The depreciation has been rather low for an old plant. When new pipes are laid, and a new source

connected with the system, the present pipes will stand as auxiliary reserves, and will have a great value to the system. Bringing in Calaveras water will not mean the abandonment of the existing structures and arrangement. The pipes are being overworked at the present time, but the cost of pumping to meet the extra frictional resistance of the pipes is not economical.

Questioned by Master.

It does not affect the life of the pipes, but the money has to be spent in pumping that could be more advantageously used in paying interest on new or larger pipes.

DIRECT EXAMINATION BY MR. GREENE.

I have used the agreed schedule or inventory constantly, and have relied upon it. 4287

Questioned by Mr. Searls.

I do not think that my appraisal varies in any quantities from the stipulated amounts set forth in this inventory.

DIRECT EXAMINATION BY MR. GREENE.

In connection with the appraisal, the first business was estimating the cost of reproduction of the works in the whole system. With the aid of the works, plans and inventory, I made an estimate of what was the fair cost of reproduction of the whole system as of January 1, 1914, taking into account the prices that were current, and had been current for supplies and labor for a few years prior to that time. Recently I have considered particularly the prices that ranged in the period from 1907 to 1914. I made an estimate of the cost of reproduction of all the structures of the company in this way. In the case of some construction work done within the last few years, I checked over the cost and found it was reasonable. I used the actual cost of construction as reported as the best evidence of the cost of reproduction at the present time, and I wrote the figures into my schedule for some such items. The older records of cost I gave such weight as they seemed to deserve, but the farther 4288
back a cost record is in point of time, or changes in condition, prices and labor, the less consideration I gave it in making up the estimated cost of reproduction.

In making my appraisal I drew on all the experience that I had, and the sources of information and experience that were used necessarily varied very much for the different items. I used whatever seemed to be most appropriate and best and reliable for each kind of structure as it came up. Fair reproduction cost is an amount for which the plant, under good average management, can be built, at prices that yield fair compensation or fair profit to everyone who contributes to the construction of the plant. The prices of labor and material fluctuate from time to time. In the 20 year period there

has been more than a two to one ratio between the minimum and maximum cost of iron products, covering cast iron and steel. In the decade of the nineties labor costs were very low, but in the last year or two of that decade, and beginning with 1900 and the years that followed there was quite a boom and the price of labor went up
4289 very rapidly. Since that time there has been a continued increase in the price of labor. The other materials have fluctuated, sometimes going up and sometimes going down.

In the treatment of reconstruction costs, I assume that the conditions are those of the present time in all cases; by the present time, I do not mean the last day of December 1913, but a period of several years before that time.

Questioned by Mr. Searls.

I think I had in mind ordinarily a 5 year period when I went over this valuation last year although that was not an absolutely ironclad rule. In going over the matters again this year with reference to the rate case, I have usually had in mind the period from 1907 to 1914. In making my valuation I take into account the improvements in doing a given piece of work over what they were when the work was actually done in the first instance. I assume that the work will be done in whatever manner is most advantageous at this time.

The cost of reproduction less depreciation does not necessarily govern the final determination of values in a case involving rate
4290 fixing. It is to me perhaps the most important single element, but certainly not in itself controlling. Different engineers have different methods in which to make an appaisal of property of this character. I go at it exactly as I would do if the property did not exist, and the problem was to find out what it would cost to build it. I take into account all the experience I have had, especially the cost of building similar works, or as nearly similar as may be to those that are to be estimated on, and I take into account the differences in the labor condition; the conditions of cost of materials as affected by freight and otherwise; conditions of climate, and all the conditions that there are that influence the cost of construction, and increase or decrease it above what it has been in the case of work for which I have information, and which I use as a basis in forming a judgment as to what it will cost to produce these works. Ordinarily I disregard the original conditions; the estimate relates to
4291 conditions of the present time. When I speak of the changes in climate, I mean that if I built a dam somewhere else, and know the cost of it, and I think that it has some bearing on the cost of the dam here, it may be very useful information, but it is not information that can be transferred bodily. It has to be modified by estimates for all the differences that there are as far as I can find out about them and allow for them.

In my opinion quotations of material play very little part in work of this character, and it is my experience that they are not reliable; they are apt to be quotations for different kinds of material than those that have been used in the plant. I ordinarily place very little importance upon quotations from manufacturers, either in estimating the reproduction cost of a plant, or in estimating on new work, as I do not ordinarily regard that as a reliable basis. The prices at which other work of a greater or less similarity have been done, play some part, and are often quite important. They have to be taken with a good deal of allowance, with knowledge of the conditions, and as to whether the contract prices were adequate or not. In nearly all cases there is extra work not governed by the contract, and it is very common for the final estimate that the engineer makes to the contractor for the settlement of his work in the end to differ quite a good deal from the price at which the contract was let. Contract prices are helpful, but they are not as safe a basis as the records of the cost of finished work. 4292

Somewhat different problems are presented in building small works than in building large ones. Some people are very competent to build small works, and it does not necessarily follow they will be successful in building large works; people who have been successful in large works sometimes fail to act in the most advantageous way in small works, their training is somewhat different.

In making my report, I have not intended to leave unworked any promised and reliable source of information. I consulted Herman Schussler; Mr. Herrmann, who was chief engineer of the company last year, Mr. Elliott who is engineer of the company this year, Mr. Lawrence, Mr. Sharon, and I have talked matters over constantly with Mr. Metcalf and with Mr. Eastman. I have talked with men in the pumping houses, and so on. For the most part, the figures in my valuation are my own. I was not familiar with flume construction, and I went over the data that Mr. Lawrence had with him, and I think he is more responsible for the estimate than I, although I had something to do with putting it in shape. I took Mr. Lawrence's figures directly on the roads, fences, and telephone lines. Mr. Farquaharson, a builder, made an estimate of the cost of reproducing the buildings, and ordinarily I used his figures. I did not always follow them exactly, as sometimes I thought I had reason for modifying them. 4293

In a broad way, the construction of a waterworks plant is more expensive on the Pacific Coast than it is in the East, because the freight rates add to the cost of most of the materials, and because the wages paid to laborers are higher on the Coast here than on the Atlantic Coast. The climate of California is much more favorable to some kinds of construction, and affects advantageously the cost 4294

of those parts of the work. I mean by "climate", rainfall, temperature and lack of frost. The amount of storage required in the Spring Valley system is similar to that required in other Pacific Coast systems, but it is very much greater relatively than is required in eastern systems, because in the first place the rain here falls in the winter, and the run-off occurs at the same time, and storage must be provided to maintain practically the whole supply during the long rainless summer. The second reason is that the amount of rainfall differs from year to year a great deal more in California than it does along the Atlantic Coast. Some years it is very much above the average, and in others it is so little that the run-off is comparatively small; storage must be provided to hold the excess flow of wet years, and maintain the supply during the dry years. Taking the two matters together, the amount of storage that must be provided in California is quite a number of times greater than it is in the East.

4295 The sources of supply for San Francisco are rather remote; only a few American cities have gone as far for water. There are quite a number of conspicuous cases where water has been brought farther. The possibility of earthquakes is a factor that is to be considered, and has been considered in the design of the plant; it leads to a number of different arrangements from those that might be selected if it were not for this consideration. The city is a very hilly one, and that means that the system is cut up into an unusual number of separate services, each one of those for the purpose of distribution is practically independent of the others; the fact that it is necessary to have quite a number of these services at different levels, adds to the cost of the service in comparison with like costs for eastern cities where the ground is flatter, and ordinarily most of all of the water is supplied at the ordinary low service level.

The volume "Detailed reproduction cost estimate of structural property of the Spring Valley Water Company, as of December 31, 1913" is the schedule of agreed items with the prices set opposite them as I prepared it; the summary is separately bound as a matter of convenience, but that is an essential part of the estimate.

4296 This schedule was offered and received in evidence as "Plaintiff's Exhibit 96". There was also offered a pamphlet entitled "Summarized reproduction cost estimate of the property of the Spring Valley Water Co., as of December 31, 1913, by Allen Hazen". This was received in evidence as "Plaintiff's Exhibit 97".

4304 This whole estimate was completed more than a year ago, for the purpose of the proposed sale, and these identical sheets were prepared at that time, and they have not been modified in any way. During this year I have made a great many additional studies as to the property, and have made additional estimates, and in some cases those are most exhaustive. They are all made by approximate methods; by that I mean I used the slide rule for multiplication

ordinarily, and they do not always add up exactly the same as the estimates in the last year, but they always check within the limits of error in an estimate, and I have not thought it worth while or best to make minor modifications, sometimes up and sometimes down in the estimates of last year.

In the riveted pipe in the Spring Valley system, there are 68 main items of pipe, comprising 501,421 feet, or almost 100 miles. That excludes many small items, because I thought a discussion of the 68 principal items would carry with it everything that was to be said on the very numerous smaller items. The riveted pipe averages 35½ inches in diameter, and the average thickness of the plates is .188, or practically 3-16ths of an inch. In another table I have these 68 main items arranged chronologically, showing the year in which each item was laid, the page in the agreed schedule upon which it may be found, and the reference number, which is an arbitrary number of my own, and is to aid me in referring to my own 4305
notes. I have then the length of pipe, that being the length now in the agreed schedule, not the amount originally laid, and the thickness of plates, which is under the heading, size, and then the weight per lineal foot of metal only, the tons of metal now in service, obtained by multiplying the weight per foot by the length, the tons now in service after relaying; that includes all of the relaid pipe of the same kind and of the same age that is now in the 68 items of the agreed schedule.

Questioned by Mr. Searls.

This first item, pipe laid in 1868, was Pilarcitos pipe, the main line, which was very badly wrecked by the earthquake, and a great deal of which has since been relaid in other parts of the system. This means that 222 tons of that pipe are now in place, originally laid in 9,681 feet, and 852 tons of the same kind of pipe are now in service in other parts of the system. So of the two items there were 1,074 tons of that iron laid in 1868 that were in service in the system in the inventory.

The next item is for the San Andres pipe, laid in 1870, and of 4306
this 795 tons are still in service where it was laid, and 231 tons are in service elsewhere after relaying. At the righthand side is a memoranda of the sources of the iron as far as it is known to me. There are 20,731 tons of metal, now in service in the main lines of pipe, and of this amount 2,061 tons are relaid pipe, 431 tons are steel, and 20,300 tons are wrought iron pipes of various kinds, which includes the 2,061 tons of relaid pipe. I should estimate roughly perhaps 500 tons of iron in the minor items.

Questioned by Master.

The column headed "Tons old pipe relaid" shows when the pipe was placed in its present position; it has been taken up from the preceding column, and the two columns balance; that is, the pipe

which has been taken up just balances the relaid pipe which has been put down.

DIRECT EXAMINATION BY MR. GREENE.

The tons I computed from the lengths in the schedule, and the estimated weights per foot. It is very rarely that riveted pipe is
4307 weighed; it is never sold by weight, and so the amount per foot is an estimate. When I first figured on this system I estimated the pipe as weighing the same as steel pipe, and I have a method of figuring approximately the weight of steel pipe, which I have used for ten years or more, and which is published in the "American Civil Engineers' Pocketbook", but in studying the matter further, I found that the Spring Valley pipe is somewhat lighter than the steel pipe, and I have been through this schedule again, and written in the actual weight of metal in the pipe as near as I could get at it, in place of what I should ordinarily consider the weight of steel pipe. Some of my earlier notes have the other weights, and as we might run across them, I think it well to make that explanation at this time.

Plates either steel or wrought iron are bought to gage or weight. A sheet metal plate made by rolling is never of the same thickness throughout the plate, and it is ordinarily considerably thicker in the metal of the plate than on the edges. The method most commonly used in gaging the thickness of plates with which I have had to do, is to buy by gaging. That is, if you buy ¼ inch plate it must be a full ¼ inch thick on the edges at every point. You can be sure that if it is ¼ of an inch thick on the edges, it is ¼ inch thick everywhere, and the manufacturer makes it as thin as he can elsewhere naturally, because he gets just as much money for the pipe if there
4308 is not much excess weight as if there was a good deal. That is the system on which the weight of steel pipes that I have used is based, and it works out all right for that.

In the Spring Valley System, the 54 inch Alameda pipe, and the 44 inch San Andres pipe plates were bought by gage. Under the weight system of buying plates, a person figures what a plate ought to weigh of the thickness that he wants, and he orders the plates to weigh a certain amount, and when that is done, the edge cannot be gaged, so the mills won't sell both to weight and gage, but will sell either way. On the Spring Valley lines, outside of the two I have mentioned, the plates were bought to weight, and where pipes are bought to weight they are thinner and lighter than where they are bought to gage, so in making up this schedule I have taken that into account, and have figured them on the best evidence that I had, consisting of taking the thickness of actual plates as I have had the opportunity in examining the system, and especially of the records of the weights of certain pipes before and after dipping that Mr. Law-

rence made many years ago at Millbrae, and as to which he states in his schedule, and I took that schedule as my basis for calculations. I have added 1% to Mr. Lawrence's weights of the actual straight pipe that he weighed, to cover the added weight of metal in the binds, man-holes and blow-offs, and I also added 3% for the loss and waste of manufacture. The 3% was based principally on an estimate furnished me by one of the largest manufacturers of pipe of this kind—the East Jersey Pipe Co.—in the United States. 4309

I have assumed that in case the pipe was fabricated here, there would be the same amount of waste in manufacture as there was in this large mill in New Jersey, and I should think there would be more waste possibly in a smaller mill than in a larger place.

DIRECT EXAMINATION BY MR. GREENE. 4310

The next sheet is a summary of the plates of different kinds in the system, the dates between which they were purchased, and the average age of the different kinds of plates. There are Scotch plates comprising all the plates bought up to 1884, 3,117 tons, reputed to have been made at the Thornycroft Iron Works, and averaging 45 years old January 1, 1914. Next the 5,696 tons of iron made at the Oliver Iron Works in Pittsburg, averaging 28 years old; then 5,691 tons divided between Morehead & McLean of Pittsburg, and Allan Wood Co., of Conchohocken, Pa., averaging 25 years old. Then 2,342 tons bought from the Central Iron & Steel Co., at Harrisburg, of puddled iron, averaging 16 years old. Then 1,744 tons of charcoal iron bought from the same company, and averaging 9 years old. Then 422 tons of Allan Wood Co. iron averaging 4 years old in the Pleasanton line, and miscellaneous lots of wrought iron, and I have 4311 no information as to where they were bought. 1,288 tons averaging 20 years old, and 431 tons of steel averaging 6 years old. The average of a plate in the whole system was 25 years. The summary at the bottom shows the relaid pipe classified in the same way as in the main table. The next schedule shows the main lines of relaid pipe and steel pipe. It shows when they were first laid, when they were relaid, the original location and the present location, and in the case of the steel lines, gives the approximate weight and the price per foot at which the finished pipe was bought. The relaid pipe is mainly from the Pilarcitos line, and the old San Andres line, which was superceded by the new San Andres pipe, and from the old Upper Crystal Springs line, which went from the Upper Crystal Springs Dam down the valley, by the point where the present Crystal Springs Dam is located, and which was made useless and taken up when the Crystal Springs Dam was laid; also a force main laid at Millbrae at one time, and a line at Merced, the position of which was changed. This relaid pipe has been taken up, cleaned, inspected and redipped before being relaid.

The next schedule is of certain lines of riveted conduits. In all the main lines of the Spring Valley System the pipe is thoroughly
4312 riveted and calked. The rivets are of such a size that they are fully as strong as the plates between the rivets, and the metal is calked to metal afterwards, so as to make a perfectly tight joint regardless of the joint. The rivets are sufficient so that the strength of the rivets is fully equal to the strength of the steel between the rivets; that means a maximum of about 72% joint. The riveting is very much less than standard, being in fact about 1-3 standard. The rivets are smaller than they ought to be to develop the full strength of the metal, and these were laid on lines of very low pressure, or no pressure, so that they are really conduits, and are not comparable to the pipes of the system. The slip joint pipes have no riveting between successive joints; that is, one ring slips into the next ring and is not fastened; it is not riveted or calked in the ordinary way. There is a certain amount of that pipe mainly in the same lines as the preceding ones, and that is not comparable to the standard pipe. The character of metal in these pipe lines I have studied carefully this year. For the examination last year I used information already in my possession, especially growing out of an examination of wrought iron conditions in 1898, made in connection with the Portland Maine work, where there were several important lines of riveted wrought iron pipe that had to be valued. I made a study at that time
4313 of the conditions of manufacture and sale of wrought iron plates, and also considered it with reference to some pipe lines that I was building at that time, and on the basis of that information I assumed last year that an average price for all of the iron in the system up to the last two lots from the Central Iron and Steel Co. was 4 cents a lb. This year I have been looking for all possible sources of information as to the character of iron in these old plates, and as to the possibility of getting iron of that character at the present time, and of the state of the iron market. In doing that I have made inquiries of everyone that seemed likely to know about it, but the men in San Francisco, with the exception of Mr. Schussler, I have not gotten very much information from. The other men had to do with the selling end of the business, but they did not know much about the quality of the metal. I have some information from the men who were in the various mills at the time the pipes were made. One of my partners visited most of the important furnaces, making charcoal iron and puddled iron in Pennsylvania, and found out the present state of the business, and we have taken up the question of costs with them.

I have had pieces cut from pipes of all the different kinds represented in this table, and I have had physical tests made of them by
4314 Hunt & Co. There are as many kinds of iron as there are kinds of wine, and it is very difficult to get an adequate understanding of

just what the metals are and to compare them. It is perfectly clear that the old iron in this system was of magnificent quality, as is shown by the records of the pipes in service. This old Scotch iron has stood wonderfully, and all of the pipes were in splendid condition. I have never seen old pipes in any waterworks system right through in as good order, and as free from rust and corrosion as the riveted pipes of the Spring Valley system. The carrying capacity of the pipe has been tested out by making actual measurements of the flow of water, and measuring the frictional resistance of the pipe with that flow. I have compared those with the quantities of water which would be expected to go through steel pipes of like age, and the best indications of that are the tables in the Williams-Hazen Hydraulic Table, which I had a part in the preparation of. There are no steel pipes 45 years old, so there is not any certain basis for comparison. We do not know just what very old steel pipes would carry, but these tables were made up to show the carrying capacity of old 4315
pipe of various kinds on the best information that was available at the time these tables were published. The records of the old steel pipe that we have, show in general a more rapid falling off in carrying capacity than the tables indicate; the steel pipes are corroding rather faster than we assumed when we made up the tables. With the Spring Valley lines on the basis of these hydraulic tests, the carrying capacity of the old pipes is about 13 or 14 percent greater than steel pipes of like age. That fully bears out the results of inspection of the interior of the pipes. It is the corrosion, the tuberculation that decreases the carrying capacity, and these pipes are extraordinarily free from that. Mr. Metcalf and I inspected several hundred feet of the 44 inch pipe one time very carefully inside, and there is hardly any tuberculation on it at all. Once in awhile a blister, and the coating is still soft and pliable, being practically in just as good condition as new pipe.

Questioned by Master.

Tuberculation is one kind of corrosion, but it is a kind where the products form a tubercle on the interior of the pipe, thus reducing the carrying capacity. The steel corrodes and tuberculates 4316
much more rapidly than the iron. At Rochester, a wrought iron pipe 3-16ths of an inch thick laid in the early 70's is still is service, and in perfectly good order, as far as I know, and it has maintained its carrying capacity, whereas the second line parallel with it, of steel, laid in the early 90's has become corroded to such an extent that it has caused a good deal of anxiety, and the steel pipe is considered less efficient than the wrought iron pipe. The second line was built by the same man as the first, and I think he was one of the most competent pipe men in the United States, and took every precaution in the second line. The steel that was used at that time was probably not exactly of the same quality as the steel that is used today.

About 1890 steel very rapidly replaced wrought iron, because it was cheaper, and it was stronger, and because it could be obtained
4317 in much larger sheets. It seemed to be better business to buy it, and the cities of this country commenced to lay steel pipe very generally, and that went on for some years, and then the first lines that were laid commenced to give trouble by rusting, especially by perforation. The rust would take the form of pits which would go clear through until the pipes leaked, and when some of the important early lines of steel pipe commenced to leak at quite a number of places, and it was talked about in the technical papers, there was a strong reaction and a tendency away from the use of steel pipe.

In the case of the Portland Water District, the trustees decided to use cast-iron pipe at a 50% increase in cost over the steel pipe, because they were afraid of the rusting and perforations in the steel pipe. From this the wrought iron pipe was very much more desirable than the steel pipe which had replaced it. The wrought iron industry in the United States since 1890, in a general way, has been a declining one, but there is still a good deal of wrought iron made in Pennsylvania, and the adjoining states. Broadly speaking, the iron which is on the market today can be classed into two general classes, the puddled iron and the charcoal iron. Puddled iron is made by puddling in an open hearth furnace in which the pig iron is melted on a bed of iron ore. It used to be stirred with wooden bars, but recently they have stirred it with iron stirrers, and the iron ore and the air oxidize the impurities in the pig iron, and as the
4318 iron becomes purified, the melting point is raised, and the furnace isn't hot enough to keep the wrought iron melted, so that it comes out of the melted pig iron something as butter comes out of cream in the process of churning, seemingly a solid lump of the wrought iron, which gradually separates from the molten pig iron, and that iron is taken out, worked under a hammer to get rid of the excessive slag, and then put through rolls and made into the first condition of wrought iron which are used in subsequent manufacture. Iron made in this way has a mass of slag all through it, which results from the oxidization of the impurities in the iron itself. This slag is like a sponge; the interstices of which are filled up with metallic iron, and it seems to be this sponge of slag which is a very hard and durable material which protects the iron from corrosion. Iron made in this way resists corrosion to an extraordinary extent.

In a house which I have owned in Vermont which has a great deal of iron trimmings; the house is over 90 years old; the iron has never been painted within my recollection, and there is not a particle of rust on it. If it were to be replaced with steel at the present time it would be so rusty in two or three years that you could not do anything with it. I saw some iron work taken from the bottom

of a very old well that had been there for a long number of years, and it was in such good condition that the marks of the manufacturer were still on the iron. It practically had not rusted at all in perhaps centuries resting at the bottom of the well under water. That is what this wrought iron was. The iron differs from steel primarily in this respect, that the process of making steel is carried out above the 4319
melting point of the finished product, and all this slag comes to the top and is carried off, and the steel is free from this slag, and when it is exposed, the corrosion goes forward without anything to obstruct it. Puddled iron is made into sheets by two mills in Pennsylvania at the present time; one mill, the Glasgow Iron Co., rolls sheets a quarter of an inch thick and thicker; the Allan Wood Co. rolls sheets thinner than a quarter of an inch. Since 1907 there have been several other mills in Pennsylvania and Ohio that have made puddle iron sheets, and some of them may be operating now. It is common for these mills to make sheets of several different qualities. If that bloom is rolled directly out into the sheet, it makes a wrought iron sheet that may sell, but it will bend with the grain; that is, it will bend in the way in which it is rolled only, and not in the other direction; it is pretty brittle, and therefore not suitable where much work has to be done on the metal, and to correct that it is customary, where the better grade of metal is required, to take these blooms, roll them out, not too thick, cut them up into pieces, fasten these pieces together after they are cold, get them quite hot, and roll them out again in the other direction, and a metal that is twice rolled in that way, is laminated iron. Iron made in that way has better physical properties, and it also has been thought that it has more resistance to corrosion, because in addition to the mass of slag, it had an additional mass between each successive layer of the metal that 4320
form the pile, and which are rolled out with the rest of the sheet. When iron is piled in that way for re-rolling, there is always a temptation to cheapen the product; that can be done by interspersing old iron with the pieces of the blooms, and at the Glasgow Mills, they buy all the old iron scrap they can get and break it to make sure that it is iron and not steel, and they make one grade of plates which is made partly of the new bloom, and partly of the old iron scraps. If they were to use steel scrap they could still further greatly cheapen the product.

For a better grade of iron, charcoal iron is used. That is the second main class of iron. The type of charcoal iron is Swedish and Norwegian, made from ores that occur in Sweden and Norway, and reduced entirely by wood charcoal. It is a wrought iron, and a very pure iron. It has the sponge slag through it, and in that respect differs from the ingot iron, which is a new product which has come on the market in the last two years, and which comes into competition with these irons. There is a steady sale for this charcoal iron

in the United States. It is better for blacksmith work, and is quite largely used for boiler tubes. Some railroads use it in locomotive manufacture. In this country a modification of the process of making charcoal iron has been developed, and is being carried on at the present time at four furnaces in Pennsylvania, and one in Ohio. By that modification a couple of hundred pounds of scrap steel are put
4321 in a small furnace on top of the charcoal iron fire, and heated, and the steel melts and flows down through the fire, and the impurities become oxidized so that it collects as a mass of iron below the fire, below its melting point, and the rest of the treatment follows the lines of puddled iron. There is a steady sale for iron of this quality at a very much higher price than puddled iron, and keeps these furnaces that I speak of pretty busy.

Puddled iron is used to such an extent that somewhere between 10 and 15 percent of all the welded pipe used in the United States is made of puddled iron, and not of steel at the present time. As a trade proposition, a small steel pipe is commonly sold under the trade name "wrought iron pipe", and I think anyone in the business will sell steel pipe for wrought iron if he has the opportunity, and the only thing that will prevent him from doing it is a specification of the purchaser who really knows the difference and insists on getting puddled iron.

In the Spring Valley specifications there was a clause that required that the iron should be capable of scarfing to a fine edge cold; a very difficult requirement for puddled iron to meet. It must have made the makers of iron a great deal of trouble. The company always maintained an inspector at the mills where the iron was made, and apparently the inspectors were very rigorous, and insisted upon
4322 the quality of metal that was obtained. There is every reason to believe that the very best obtainable iron was in use in all of these earlier orders. The second lot from the Central Iron & Steel Co. was all charcoal iron. I have been through the inspectors' reports on that, and they leave no possible doubt upon that question. The earlier lot of iron from the Central Iron & Steel Co. was puddled iron of a superior grade, and the earlier iron, Thornycroft Iron, the Oliver Iron, the Morehead & McLean, and the Allan Wood Iron, I think also were puddled iron. There has been some reason to think that some charcoal iron was rolled with the puddled iron in some of these earlier orders, but I do not find anything to fully substantiate that view, and I am proceeding on the theory that this was all puddled iron of the very best quality. The Allan Wood iron in the Pleasanton pipe was a good grade of puddle iron of the kind that is being made at the present time.

SIXTY-SECOND HEARING. NOVEMBER 17, 1915.

Witness: ALLEN HAZEN, for Plaintiff. 4323

(Certain corrections noted in the record).

Tables used by Mr. Hazen received in evidence as "Plaintiff's Exhibit 98, 98a, 98b, 98c and 98d". 4324

DIRECT EXAMINATION BY MR. GREENE. 4325

(Mr. Hazen and Mr. Dockweiler agreed on the price of 4 cents a pound for the plate in San Francisco, excluding the steel and the Pleasanton wrought. Mr. Dillman started with 5 cents as the price of the pipe fabricated, which would not be the same).

Charcoal iron: I have the following prices paid for charcoal iron. In 1898 a small order of bends in the San Andres line, 3¾ cents a pound at Harrisburg, 4½ cents a pound in San Francisco. In 1902, metal for 54 inch Alameda line was bought under contract for 3.90 cents per pound at Harrisburg, or 4.65 cents per pound in San Francisco. In 1908, small order of sheets at 4.15 cents per pound at Harrisburg, 4.90 cents per pound in San Francisco. In 1908, in connection with the valuation of the Portland, Me., water works system, the superintendent of the Central Iron & Steel Co. gave me as a fair price for charcoal iron at that time 4.50 cents, equal to 5.25 cents in San Francisco. They have since ceased to make charcoal iron, and the only place it can be bought at present is the Allan Wood Iron & Steel Co. They have recently given me as a fair price for estimating, representing recent years, and with the qualification that deliveries could not now be made at that price, 4.95, equal to 5.70 a pound in San Francisco. 4326 4327

Questioned by Mr. Searls.

The first three items are for actual orders, and were usually for plates ¼ inch, or a little more in thickness. The quotation in 1908 was for thickness of plates that we had in hand, which was not very different from those in this system. The 1915 quotation was for plates of similar thickness to those in the Spring Valley system. The thinner plates cost more per pound than thicker ones.

Table entitled "Prices and Quotations, Charcoal Iron", marked "Plaintiff's Exhibit 98e".

Puddled iron: In 1884 the actual price for the metal in the Crystal Springs line, made by the Oliver Iron Co., 4 cents per pound. In 1887 metal for Alameda pipe line, order divided between Morehead & McLean, Pittsburg, and the Allan Wood Iron & Steel Co., Conshohocken, 4.07 cents per pound f. o. b. San Francisco. In 1897, metal for San Andres pipe line, made by Central Iron & Steel Co., Harrisburg, cost 1.75 at the mill, or 2.50 at San Francisco. This

order was placed at a time when iron products were at the lowest
4328 prices that had ever been reached. Steel was selling for around a cent a pound, and cast-iron pipe for $17 or $18 a ton in the East. Also the specifications for the earlier lines had been very severe, whereas in this case there was a relaxation of specifications, and the same qualities of metal were not demanded. This was of a very excellent grade, but it was not the same grade as the preceding orders. In 1897 an additional order from the same mill cost ½ cent a pound more, 3 cents per pound in San Francisco. In 1898 plates cost still more, 3¼ cents a pound in San Francisco. In 1900 plates cost 3.40 per pound in San Francisco. In 1908 pipe for the Pleasanton line, sold by Allan Wood Iron & Steel Co., and bought by the Spring Valley Co. from Francis Smith & Co., but the Allan Wood Co. informed me that they received from Smith & Co. 3.20 per pound for this iron. It was not made under the specifications used in the preceding lines, and is not the same kind of iron, and is not comparable to the other orders. In 1908, in connection with the Portland water works valuation, the Central Iron & Steel Co., Harrisburg, quoted me as a fair price for refined iron at that time 2.75 cents a pound, Harrisburg, or
4329 3.50 cents a pound at San Francisco. The Youngstown Sheet & Tube Co. quoted me the same price. Recently the Allan Wood Iron & Steel Co. have given me a quotation for the kind of sheets that they are making, which are not, I believe, comparable to the earlier sheets in the system, of 2.60 cents a pound at their mill, equal to 3.40 in San Francisco.

Table entitled "Prices and Quotations for Puddled Iron" marked "Plaintiff's Exhibit 98f".

Witness presented a table of the average prices of steel in Pittsburg during a 20 year period, and showing also the additional prices for thinner plates as compared with plates of standard thicknesses, and additional prices of various grades of steel of superior quality. It was marked "Plaintiff's Exhibit 98g".

Questioned by Mr. Searls.

4330 Ordinarily I figured 75 cents a hundred, which is the prevailing standard rate, for freight.

A diagram prepared by Mr. Metcalf showing the fluctuations of steel prices, was received and marked "Plaintiff's Exhibit 98h".

It has been a practice in the Spring Valley, beginning a very long time back, to report the weight of plates in pipes; that is the theoretical weight of the plate without the rivets. I have come across these figures repeatedly. The estimates do not represent the weights of metal in the pipe, because in the first place, they do not include the rivets, which amount to about 4%, and in the second place, because no allowance is made for the excess weight of plates above the theoretical, and no allowance is made for loss in weight, or extras for bends, or any other purpose. The figures I used as representing

the actual weight of metal in the pipe overrun the Spring Valley figures by amounts that average about 8¼%, it varying considerably in the different lines. That is a different method of estimate, and does not represent any discrepancy in the data. If one does not keep these differences clearly in mind, there may appear to be a discrepancy that does not really exist.

In estimating the cost of riveted pipe, there are certain office 4331
methods and short cuts that have grown up as a result of experience, and that are ordinarily used, but that are difficult to explain concisely and show adequate reasons at every point. I followed the ordinary procedure that I use, and consider perfectly sound, and I shall depend largely on the supporting schedules that are arranged to support the figures that are reached. As a result of that study, and of the conditions in San Francisco as I found them, I concluded that steel pipe, with plates ⅜ of an inch thick would cost 5.7 cents per pound, reckoned not on the weight of the metal only, as in these tables, but on the whole weight of the completed pipe by the formula which I ordinarily use, and which does not give exactly the weight of the Spring Valley pipe. 5/16 pipe would cost 6 cents a pound. 4332
¼ pipe would cost 6½ cents a pound. 3/16 inch pipe would cost 7 cents a pound. ⅛ inch pipe would cost 8 cents a pound. That would include not merely the pipe, but also the excavation, gates, bends, blow-off, air valves, and all ordinary fixtures along the pipe line. It would not include very unusual appurtenances or obstacles. In estimating in that way, I followed the ordinary method that I use, because experience in building pipe lines has shown that there are a great many obstacles to be met, and expenses to be paid that naturally would not appear in any schedule of agreed quantities after the work was completed. In my experience the allowance I make is sufficient to cover an average amount of the extra expenses that are incurred along the pipe line. Those prices were for steel pipe. Substituting wrought iron plates at 4 cents a pound, for the steel, I concluded that the cost of the completed work in cents per pound, on the weight of the steel pipe dipped, and not the weight of the metal only, would be; ⅜ plates 7.4 cents per pound; 5/16 plate, 7.7 cents per pound; 0.275 plate 8 cents per pound; ¼ inch plate 8.1 cents per pound; No. 6 plate 8½ cents per pound; No. 7 plate 8.6 cents per pound; No. 9 plate 9.1 cents per pound; No. 10 plate 9.3 cents per pound; No. 11 plate 9½ cents per pound; No. 12 plate 9.8 cents per pound. If you 4333
will find the weight of each length of pipe in the schedule by the rule that is given in the American Civil Engineers' Pocketbook, which is W equals 12.5d. t. plus 10, and then multiply that weight by these prices per pound, you will get the prices that are written in my schedule. Those prices include not only the pipe laid, but the ordinary excavation, gates, air valves, blow-off, ordinary obstacles and difficulties along the line. The letter "w" means weight in pounds per

foot; "d" means diameter, and "t" means thickness. When I speak of excavation, I include the filling in afterwards. I reached the price of the pipe completed and laid.

Questioned by Mr. Dillman.

The weight of the pipe in the system, as computed by this formula, is approximately 23,400 tons. The actual weight, as nearly as I can get it, of metal, is 20,730 tons, of coating 2,000 tons, so that the
4334 actual weight of the coated pipe is about 22,730 tons. This formula gives 22,040, a difference of about 700 tons more, or about 3% more. The theoretical weight which I have figured on is something like 13% more than the actual weight of metal.

DIRECT EXAMINATION BY MR. GREENE.

The weight computed by this formula might be called the theoretical weight; it really corresponds to the average weight of steel pipe of those dimensions, and this pipe is actually somewhat lighter. That is why I went into these refinements. I thought if I was using pipe corresponding to the formula, and the actual weight was a little less, of course as the weight is less, the price per pound is more, and that would tend to balance.

It is my ordinary practice in estimating pipe, to estimate for the pipe laid complete; separating it into cost of plates and of manufacture is not ordinarily attempted, but it seemed necessary to make the separation in this case, because the plates are of somewhat special character, and also because the same method has been followed in
4335 other systems along the Pacific Coast; in other words, it has been common here to buy the plates and metal, and have them made up by someone.

I have three lines of evidence. The first is a memorandum of October 30, 1912, and is the basis that is worked out in our office, and corresponds to the figures used in the American Civil Engineers' Pocketbook. That was what I took as a basis for working up these figures I have just given you, and I am going to use them now to get the separation between the metal and the cost of manufacture. The second is contract prices of steel pipe in comparison with the prices of steel at the time, the cost of manufacture being ascertained by itself; and third, the Spring Valley records and experience.

First: The schedule of October 30, 1912; based upon an assumed average cost of steel plates at the mill in Pittsburg, of 1½ cents a pound; that is about the average price both for a 20 year period, and for the last 10 year period. This was all worked out with reference to the eastern field, and the freight rates would not be the same to all points, but they would not vary very widely from the figure I have mentioned in most of the places where they have data. That makes 1.7 cents per pound, with freight to point of use. The base price for quarter inch plates in pipe laid, riveted, calked and trenched, is 4.2

cents per pound. Subtracting 1.7 cents for the plate and freight 4336
leaves a difference of 2.5 cents per pound. This must include the cost of manufacturing, all the costs of hauling and transportation, except the freight as above, and the contractor's profit. We take as an office base 4.2 cents per pound for the pipe made up f. o. b. at the point in the east, for use, and subtracting the price of steel, and the average freight, it leaves 2½ cents, which represents the cost of manufacturing, hauling and transportation. The corresponding figures for 5/16ths, and ⅜ths plates are put in this table, and the cost of manufacturing for these three thicknesses runs 2.5, 2.2 and 1.9, a difference of .3 of a cent per pound for each 16th in thickness. Thinner pipe costs more per pound. Spring Valley pipe averages 3/16ths of an inch thick, and the schedule of October 30, 1912, did not extend to 3/16ths plates, because we seldom lay pipe less than ¼ inch thick, and no provision was made for estimating it in this schedule. Extending the schedule by extrapolation by taking the difference between the successive sixteenth and adding it to the last one, the estimated allowance for manufacturing 3/16th plates would be 2.8 cents per pound. These figures are for steel pipe, and the cost of manufacturing wrought iron pipe may be greater because the plates are narrower, and more rivets must be driven, and more calking be done. Three cents per pound would be a reasonable figure for use for 3/16ths wrought iron plates as deduced from the above table. This is calculated in all cases on the finished weight of pipe, including the weight of coating, and represents eastern cost. With these steel pipe 4337
lines the weight of the coating ordinarily runs pretty close to the weight of the loss of metal in the process of manufacturing, so that the metal bought corresponds pretty closely with the weight of the coated pipe finished. In these calculations no allowance is made for any very small difference that there may be.

Second: I studied the record of contract prices that we have for the last few years, and made a comparison of these with the cost of steel plates and freight rates. 15 recent contract prices were available in my note book. The cost of steel plates is taken for this purpose as the average at Pittsburg for the year in which the sale was made, as recorded by the Iron Age. I have taken into account fluctuations in the year. Freight rates are from Pittsburg to the point where the pipe is laid; in some cases exact rates are not used, and approximate rates are used. This table is divided into four divisions; the first for pipe made from quarter inch plates f. o. b. cars at the point designated. The first item in 1909 for pipe at Portland, Ore., which cost 3.51 cents per pound figured on the nominal weight in all cases, the actual weight not being known; the actual price of steel plates at Pittsburg for the year was 1.42 per pound. The approximate freight rate from Pittsburg to the point of delivery was 0.75 cents 4338
per pound. Deducting those two items from the contract price for

the pipe f. o. b. Portland, leaves a difference of 1.34 per pound. The next item is for pipe at Ottawa, Canada, which cost 7½ cents per pound; the next is for pipe at Winnipeg in 1913. The next division of the table differs from the first in that the contract price includes delivering the pipe along the trench, riveting and calking it. It costs more per pound that way, and is kept separate in this schedule for that reason. Portland, Oregon,—the calculation being made in the same way—coming out 2½ cents a pound; Los Angeles, 2.84 cents per pound; another one from Los Angeles 1.73 per pound; Akron, Ohio, coming out 2.28 per pound; and two from Los Angeles coming out 1.39 and 1.79.

Questioned by Mr. Searls.

I obtained the data from inquiry, and did not take copies of the contracts, or see the original contracts, with the exception of a few. In our own practice we have usually made contracts for the pipe, in-
4339 cluding more than is included in these tables. This discussion is limited to ¼ inch and 5/16ths plate, being the best that I could get for this purpose. There is no use considering very thick plates, because they would not throw much light on the cost of manufacturing pipe from thin plate. I put the 5/16ths pipe in the same way into two classes; one for the pipe f. o. b. cars near the point of laying, and the second for the pipe in the trench, including riveting and calking, but not including the excavation. In all there are 15 of these items, and they are summarized in comparison with the corresponding cost of our office schedule of October 30, 1912. They all add up 33.09 as against 32.20; the cost of manufacturing as calculated in this way averaged 0.06 of a cent per pound, or 2.75 percent more than the amount shown by our office schedule for the same items.

Questioned by Master.

The 89/15ths is the difference between the sums of the two
4340 colums set forth on that page or between 33.09 and 32.20. The fairest basis seems to be to take matters as they stand, and doing it in this way, the indications are that the schedule as it stands is substantially in accordance with current average contract prices. These are mainly for eastern work, and represent manufacturing divisions in eastern shops. That is true even where the work was done on the Pacific Coast, as was the case with many of these contracts, because the pipe was made in the east and shipped to the Pacific Coast; the manufacturing was done in the east, so that it reflects eastern manufacturing prices, and not prices on the Coast.

DIRECT EXAMINATION BY MR. GREENE.

Third: Spring Valley experience; the company has a record of the cost of manufacturing straight pipes representing 63% of the entire system. This is made up from the records of the company which I have examined, and covers the cost of straight pipe only, with

the exception that the weight of metal per lineal foot is my estimate of the actual weight, and the cost in cents per pound is also computed on that basis. These prices include manufacturing in the shop, and making the joints in the trench, but do not include transportation nor dipping. It covers just the straight pipe, and the average cost is 2.87 cents per pound. Records of the cost of manufacturing bends 4341
and man-holes are limited. Records are available for only two of the larger pipe lines. I also have a record of the cost of similar work on a line at Portland, Oregon.

The table shows the cost of manufacturing the bends and man-holes on the San Andres and the Alameda 54 inch pipe. For the San Andres pipe Spring Valley paid $96,665.26. The straight pipe was $83,780, leaving $12,885.26 for bends, man-holes, etc. The weight of the metal in the pipe was 3,786,000 pounds, the cost per pound 0.342. Alameda pipe; there was a charge for 105 straps at $52 each, which makes a total of $5,460; for unloading plates, $751.20; other charges on manufacture $2,219.55, making a total of $8,430.75 outside of the cost of manufacturing straight pipe, which was actually paid to the manufacturer; that amounts to 0.266 cents per pound.

Mr. Clark, engineer of water works at Portland, Oregon, gave me the cost of laying pipe lines, and I went over the pipe lines with him, and from that the following figures are taken: Manufacturing bends $20,490; man-holes $4,120; total $24,610, equal to 0.192 cents per pound. The average of the three records is 0.267 cents per pound, and the average for the two in the Spring Valley system is 0.304. I do not think the Portland work is quite comparable, but it is interesting as a confirmation.

The man-holes in our practice are always furnished by the manu- 4342
facturer as he desires, and it makes no difference with the price, and in the same way on our work the bends are usually included with the pipe. The plans show just what the bends will be, and the bids are taken on the pipe including the bends. In the Spring Valley practice, Portland practice, and in much of the Los Angeles practice, the work has been otherwise arranged, so I made these classifications to help me in the comparison.

The cost of dipping pipe was agreed to by myself and Mr. Dockweiler on May 14, 1914, and the price that I agreed on with him seems fair to use in rounding out this schedule. I do not think it necessarily follows that that was the actual cost, as the agreement is as to the fair cost of doing the work at the present time. The dipping of the Spring Valley pipe has been very good. This schedule shows the size and length of pipe, and the cost of dipping per foot, as agreed upon with Mr. Dockweiler.

The weight of the coating, figured along the lines that I talked 4343
over with Mr. Dockweiler at the time we agreed as to the cost of dipping figures out 1,950 tons, equal to 9.4 percent of the metal. The

cost of transportation from the shop to the ditch for those lines for which records are available have been as follows, and are based on the weight of the coated pipe, and not on the weight of the metal alone; Alameda pipe line 1888, contract price 15 cents per foot, $3.60 per ton; San Andres pipe line 1898, the record is incomplete. The record for 392 lengths figures out $4.15 per ton. San Andres pipe line 1903 partial record, with some items omitted, comes out $3.38 per ton; I estimated the omitted item, bringing it to something like $4 per ton. The average for these three Spring Valley items is $3.90 per ton. As a result of my familiarity with the business elsewhere, I concluded that $5 per ton was about what it would cost to transport the pipe. That is fully borne out by this record, because most of the work done by this record was done before the increase in prices. At present
4344 prices it would cost a good deal more than is represented by this table.

The basis of this partial information of actual cost of manufacture of the Spring Valley pipe, beginning with 1884, was approximately as follows:

Making straight pipe by contract, 20,730 tons of metal, at 2.873 cents per pound, being the figure which I reached in a preceding table.	$1,191,100
For making bends and man-holes on same, the same weight, 0.304 cents per pound.....	126,000
For dipping the pipe, at the rate agreed with Mr. Dockweiler	178,000
For transporting pipe, 22,700 tons at $3.90 per ton	88,500
Total probable actual cost of manufacturing	$1,583,600

The cost per pound of metal 3.82 cents per pound, which means the cost of manufacturing per pound of metal.

In connection with this estimate, two important factors must be
4346 borne in mind: First, the price of labor has greatly increased, and this would tend to increase the cost of manufacture at the present time. Second, the mechanical appliances for making pipe have been improved, and it can be more cheaply manufactured at the present time. This tendency probably offsets the increase in the price, on account of cost of labor, and this refers to all the matter, and not merely the last table. The earlier estimates were based primarily on eastern data, and reflects the cost of manufacturing in eastern shops. The cost of manufacturing in San Francisco shops would be higher at the present time, and during the period from 1907 to 1914 than it was when much of the pipe was made.

Questioned by Master.

I mean, by the present time, an ample period of construction prior to January 1, 1914, and calculating particularly on the period from 1907 on. As a matter of fact, many of my estimates were made

up before 1914, and I have not modified them. In my estimated re- 4347
production of this riveted pipe, my figures are based upon any improved mechanical appliances that there may be. I have not taken into account special improvements such as the reduction in freight due to the Panama Canal, because materials could not have had the advantage of that reduced freight rate and been used in the system during the period under discussion. I should say any improvements in manufacture or methods that are supposed to have occurred, but which occurred so late in the period that they could not have been availed of in this period, ought to be excluded. Otherwise, I am figuring on the most advantageous method of construction available to anyone building a system of this kind. I have considered a little the question of making pipe elsewhere. It would be possible to make the pipe in the East and ship it to San Francisco—that is what I figured on last year—instead of shipping the plates and making the pipe in San Francisco—as I am figuring on in the present estimate. This would result in a certain economy of manufacture. It would not be possible to always get full carloads of pipe made from such thin sheets as those in the Spring Valley system, and the minimum weights would result in an addition to freight bills over the quoted rates. That is to say, the freight rate of 0.75 cents per hundred is based on having a certain rate on a car; with the pipe in this system, it would not be possible always to put a full carload of pipe on a car, and the minimum carload would have 4348
to be paid, even though the actual weight was less, therefore the freight would be greater. Freight would also have to be paid on the coating, which amounts to nearly 10% of the weight of the pipe. This coating is obtained in California, so that the freight bill will be considerably increased on that account. Pipe can be manufactured more cheaply in Los Angeles than in San Francisco at the present time, but it is not thought that this difference would be enough to make it pay to ship the plates from Pittsburg to Los Angeles and then to ship the fabricated pipe from Los Angeles to San Francisco. Some very low prices for manufactured pipe in California have been quoted to me by various people. In some cases they represent inferior metal and workmanship. In some cases the pipes are greatly under-riveted, and the calking of the seams has been imperfectly done, or omitted altogether. For these reasons records of such sales at low prices, where the conditions are not comparable to those of the Spring Valley pipes, have been disregarded.

Metal frequently comes to shops on the Pacific Coast and is made up without inspection. There is a great difference in the quality of steel. When steel is drawn from a furnace it is first cast into an ingot, perhaps 18 or 20 inches square and 6 or 7 feet high, and weigh- 4349
ing 5 or 6 tons. The steel solidifies in this mold and forms the ingot. You know how artificial ice forms a solid mass at the bottom, and as

air bubbles, the impurities concentrate in the middle at the top. It is exactly the same with steel in the ingot. The top of the ingot cools last, and where these impurities collect is called the pipe, which extends quite a long distance down in the ingot. It is customary to cut the ingot into five pieces for the purpose of rolling into plates, and if one wants a good grade of metal, it is customary to exclude for pipe making the top fifth of the ingot, and if the pipe shows after the top fifth is cut off then you exclude the second fifth. The metal cut off is ordinarily used for making steel freight cars. We do not think it ought to be used for pipes, and are in the habit of paying an additional price for metal from the bottom of the ingot for the sake of having this separation made and excluded; we think it is worth while to do that. The last order of plates that were rolled under my inspection, in Pittsburg, we excluded a great deal of this inferior metal at the top. If one is willing to buy steel without inspection, inferior metal from the top of the ingot can be got at cut rates through dealers. It is obviously possible to make up pipe from that kind of metal and at a price that ought not to be applied to a discussion of good first-class pipe.

4350 In regard to the manufacture—there is a certain amount of riveting that is necessary to develop the full strength of the pipe. A good engineer will figure that out and specify it, and insist on its being done. I have seen pipe made on the Pacific Coast, sold—reputed to be good pipe—that had not more than one-third the amount of rivets in it necessary to develop the full strength of the pipe. In good standard work the joints are calked. That is, where the two plates come together and rivets go through, after the rivets are driven, and it is drawn up, a calking tool goes along the edge and forces the steel down until this plate is in absolute contact with the under plate at every point. Usually that calking is done on both edges, and it is also customary to shear the plates on a bevel. That is, instead of shearing them straight, to cut them at an angle and facilitate that calking. I found that sometimes they calked only one side, the beveling is commonly omitted altogether, and sometimes no calking is done at all. Some lines, for which I have data, have been done by split calking. That is, instead of driving the whole bottom of the plate down, they permit the calker to split the plate and drive the lower part of it down, a cheaper and an inferior method of procedure. I do not think we can take the price of that pipe as an indication of what the cost of standard work is, unless one is sure that the work is done under proper supervision and inspection, and is done as it ought to be. To make the comparison otherwise is like trying to haul the tailor down to the price of ready-made suits. In one case the work is thoroughly made from good materials, and in the other case it is imitation. It has some of the main dimensions, but may be different in other particulars.

Then there is the difference between buying plates to gage and buying them to weight. Buying to weight is a very common practice, and for ordinary sizes of pipe probably amounts to 8 or 10 percent difference in weight, thickness, and in cost. All evidence as to the cost of steel pipe is considered in a somewhat tentative manner. There is much more information relating to steel than there is to wrought iron, and in a broad way the evidence as to steel is helpful, but it is not considered that the two materials are so far identical that records of work done in steel can be used without modification in making estimates for wrought iron. The prices per pound for pipes made from thick plates are not applicable to pipes made from thin plates. The cost per pound increases as the plates are thinner. In the Spring Valley records there is no clear cut indication of a higher cost per pound for manufacturing pipes from thin plates than from thick ones, but I think the data is hardly adequate to establish that point, and for the purpose of this estimate I shall use a flat price per pound, and I do that with the reservation that I know absolutely that it does cost more to manufacture thin plates than it does thick ones; if we get into it far enough to know anything about it, we shall find that there is quite a substantial difference. 4351

I have made a comparison which I have headed as follows: Cost of manufacturing, coating, transporting finished pipes from shop to trench, and connecting up and calking in trench, including bends and man-holes, but not gates, air valves, blow-off, anchorages, connections, excavations, and so forth, in cents per pound. The schedule of October 30, 1912, represents our eastern price on the nominal weight 2.8 cents per pound. The actual record of 15 recent contracts overruns this by 0.06 cents per pound. Adding this we get 2.86, representing recent contract prices. If work is done in San Francisco, I estimate that the cost will be 20% greater, or 3.43 cents per pound. If the cost is reckoned on the metal in the pipe line instead of on the nominal weight of the finished pipe, the cost per pound is increased about 9.4 percent, or the weight of the coating. The price per pound without the coating would increase in the same percent as the percentage of coating on the pipe, or to 3.75 cents per pound. The probable actual cost of Spring Valley pipe since 1884 for main items only has been as follows: 4352

Manufacturing and laying straight pipe, per lb. metal	2.873
For manufacturing bends and man-holes	0.304
For transporting per ton of dipped pipe, increased by the 9.4 percent, and reckoned on metal only	0.212
Dipping, at the rate agreed on with Mr. Dockweiler	0.430
Total, per pound, in round numbers	3.82

In other words, the 3.75 that I reach in the other way checks almost identically with the actual cost of laying the Spring Valley pipe.

That is a coincidence, and I do not attach any significance to it at all.

In view of all the circumstances as developed in the above analysis, the average cost of 3.75 cents per pound for metal used, including plates and rivets, may be taken as the cost of manufacturing, including the making of the pipe in the shop, dipping it,
4353 transporting it from the shop to the trench, making the joints in the trench, and calking them. For the pipe in the system where slip joints are used, a deduction of 1 cent per pound may be made. For these pipes which are built as conduits with less than the full amount of riveting, and without full calking of the seams, a deduction of 1 cent per pound is made. For slip joint pipe built as conduits, two deductions of 1 cent each may be made, reducing the cost of manufacture to 1.75 cents per pound.

Referring to an estimate of cost of reproducing 501,422 feet of riveted pipe in the 68 main items of the schedule: I have entered first what I call extra quality puddled iron; the older iron of superior quality, laminated by piling, re-heating and re-rolling, specified to be capable of cold scarfing to a fine edge. There are three items in this class; the Thornycroft or Scotch iron; the Oliver iron, from Pittsburg, and the order that was divided between Morehead & McLean, and the Allan Wood Co. I have taken all those at 4 cents per pound, which is a little more than the current price for good puddled iron, but I consider that iron of the quality represented by
4354 these lists is not on the market at the present time, and to get it as closely as may be would involve using extra specifications and precautions, and added cost. I believe that 4 cents f.o.b. San Francisco is a fair price to use in that way. There are two items of ordinary puddled iron, one from the Central Iron & Steel Co., which is in the San Andres pipe, and a small order from the Allan Wood Co., in the Pleasanton line, which I took at 3½ cents a pound; those representing material that can be obtained at the present time, and the price that has ruled in recent years. To that I add a miscellaneous list of iron, the history of which has not been traced; it is quite an important item, and I have put it in at the same price. I think probably that further information would show that perhaps most of it should go in the 4 cent class. Then an item of charcoal iron, laminated by piling, re-heating and re-rolling. One item, the 54 inch Alameda at 5½ cents per pound, was special iron. The quotations for charcoal iron, simply as charcoal iron, do not I think represent all the work that went into this iron, or all the value that is there. Then for steel, 4 small items; one item ¼ inch plates 2¼ cents a pound represents 1½ cents at Pittsburg, which is the average base price for steel, and 0.75 cents for freight. Then an item for flange steel, which went I think into the Alameda line, at a trestle at a difficult place. That is estimated at a higher price because of its

extra quality, and because it is thinner than quarter inch. Then an item of No. 12, which is assumed to be of ordinary quality, and 4355
an extra allowance because of thinner gage, according to the schedule which I have submitted. The same with the last item. It all adds up $1,657,384, or exactly 4 cents a pound for the whole system. For manufacturing, laying, dipping, transporting and laying, 20,713 tons, at 3¾ cents, $1,554,825; from that I deduct for under-riveted and under-calked pipe, 542 tons, and for slip joint pipe 670 tons, a total deduction of $24,240, leaving a net amount of $1,530,585.

Questioned by Master.

The items of under-riveted and under-calked pipe are determined by my inspection; that is not in the schedule. The slip joint pipe is by my inspection. I mean by that it is by my inquiry and seeing samples of it, and of inquiring where it was used, and how much.

DIRECT EXAMINATION BY MR. GREENE.

Excavation: Earth and rock 572,205 cubic yards. The excavation quantities were agreed upon for all the items of pipe outside the city. The excavation for the distribution system has been added 4356
in the same ratio as was agreed upon for the outside. I put that in at 75 cents per cubic yard including the back fill, or a total of $429,154. That adds up $3,617,123. To that I add, based on my experience, for gates, air valves, blow-off, bands, lead joints, connections, concrete in trench, contractor's extras, and all ordinary accessories and contingencies, 10% of the above item; that brings the total estimated cost to $3,978,835. I do not always add 10%, because there are some cases that call for other estimates, but for ordinary riveted pipe lines I do, because I have found that that is about what those things have run. The sum of the estimates in the schedule for the same items, obtained by multiplying the length by the quantities which I gave in an earlier schedule, and added up, amount to the figure $3,951,531. In many cases other auxiliary and allied matters are mixed up with the pipe in the schedule so that if the items are taken out in the schedule without taking that into account, the exact figure would not be reached, and that estimate, made in the way which I have just gone through, comes out a very little more than the sum of the items which I wrote into the schedule last year as a result of our office practice, and using a great many short cuts. The above figures cover ordinary work only, and do not include allowances for auxiliary structures, and for obstacles separately listed in the schedule, nor the allowances for the additional cost for laying those pipes in city streets. 4357

This memorandum marked "Plaintiff's Exhibit 98j".

4358 These sections are typical of the Spring Valley pipe, and this riveting shows the single riveting on the circular seam, and a little bit of the double riveting on the longitudinal seam. This double riveting is calculated so that the strength of these rivets is a little greater than the strength of the steel between the rivet-holes, so that if the pipe is put under pressure until it goes to pieces there, the steel will break across between the rivets before the rivets let go, and that is as it ought to be. These plates are sheared to the right dimension. When they are rolled they are white hot first, and red hot at the finish, and they can only be brought approximately to the required dimensions; they shear them as well as they can when they are hot to the dimensions that are ordered, but when they cool they differ somewhat, and have to be made the right dimensions and so are put in a machine and sheared to exactly the right dimensions. This plate, instead of being sheared clear, was sheared on a bevel, and that is the best practice. That is not always done in the Spring Valley system, but that is the best way of doing it. That edge has to be so near the rivets that there will not be that spring between this edge of the rivet and the plate. That has to
4359 be sheared and punched exactly to dimensions. When it is made all these seams are calked with a pneumatic tool. This is calked until that metal comes down into absolute contact with the metal of the other sheet, and makes it perfectly tight, and in the same way it is customary to calk on this side, so that there are two joints that are tight. It is calked from the inside also, but that has not always been done on all the Spring Valley lines.

The rivet holes are put in while it is still in the plate; then it is sheared up and riveted, the calking is done, and then it is dipped. The sheets of the older line were ordinarily 44 inches wide; in some of the newer lines they are up to 60 inches. Those pipes were put together in 4 or 6 courses in the shop, and these seams were made, and then it was dipped. The seam between the long lengths is made in the trench after it is in position. In making those seams in the trench there are various procedures followed in the Spring Valley system; sometimes they are riveted up in the ordinary way, and sometimes they are put together with a strap which goes over two ends of the same size, so that the two joints are riveted together. Sometimes they are put together with a sleeve and two lead joints, the sleeve going over, and the lead joints being made on either side. That system was followed repeatedly in going across marshes and
4360 soft places, giving a greater flexibility to the line. These pipes have what we call standard riveting, and that is the good substantial work. In the Pleasanton line you can see that these sheets are not sheared in the same way; the rivets are altogether too small; these rivets will only develop about one-third of the whole strength of the pipe. It was never calked, and could not be; the edge is too

far away from the rivets, and if they calked it they would spring the plate and it would be gone. It is perfectly suitable as a conduit for the use to which it is put, but if a piece of this were substituted in the Alameda line to perform the service that is actually being performed by that line, it would go to pieces just as quick as you put the pressure on it. If these were made as those were made, they would stand 100 pounds pressure safely. This would go to pieces with a fractional part of that.

Mr. Lawrence: All of these sections of pipe have been in use 4361
with the exception of the 54 inch.

Mr. Hazen: These are all of the puddled iron, while the 54 inch is charcoal iron.

At Springfield, Mass., 12 miles of 32 inch pipe, laid from our 4362
own plans, and under our general supervision, including excavation, bends and man-holes, cost $395,834. This pipe was laid on a very easy route. There were paid out in connection with it, outside of the above sum, the following amounts:

Rock excavation	$ 5,255
Concrete in trench	9,743
For extra work in connection with crossing the west Fall River, being a small river through which the standard construction was carried	5,000
For extra work at other valley crossings	1,500
Laid rails and protected work	600
Air valves, blow-offs and gates	6,387
Miscellaneous expenses	3,652
Extra work allowed to contract on miscellaneous matters	8,921
Total	$41,058

Equal to 10.3 percent of the main items.

On a pipe line at Albany, N. Y., where the pipe went through a city street the percentage would have been above the 10%. At Washington, D. C., where steel pipe was also laid, there was no way of separating the auxiliary costs, but the work in connection with the filtration was somewhat comparable to the work in the 4363
streets, and the cost would have run much higher than 10%. At Portland, Oregon, the cost of plates and rivets was $383,870; manufacturing, dipping, transporting and laying, $378,853; excavation, $69,410; total for primary work $832,133, and that does not include the clearing of roads. There was paid on auxiliary items the following sums:

Rock excavation	$ 29,973	
Air valves	1,040	
Blow-offs	6,166	
Blow-off valves	920	
Stand pipes	467	
Waste pipes	4,940	
Foundations	1,155	
Gates	850	
Concrete piers	4,372	
Sleeve joints	2,794	
Lead joints	2,411	
Trestles	5,783	
Bridges	4,808	$48,887
Cast-iron	547	
Miscellaneous	167	
Total miscellaneous	$110,465	

That amounts to 13.3 percent of the main items. That was perhaps a little higher than normal, because they included the
4364 bridges in the schedule. The second part of the first line laid by Mr. Clark, who is the Chief Engineer of the Portland Water Department in the municipal plant, including the same bridges, the cost of the primary items was $601,018. The auxiliaries amounted to $68,649, or 11.4 percent of the primary items.

Another line of 44 inch pipe, the primary items cost $603,023, and the auxiliaries $30,808, a total of 5.1 percent. For all the Portland work the primary items amounted to $2,036,174; the auxiliary items amounted to $209,982, the auxiliaries costing 10.3 percent of the primary items. At Brooklyn, N. Y., 3 miles of 48 inch pipe in Clarkson & Woodruff Avenue, including considerable pavement, the auxiliary work amounted to 24% of the main items. For 4 miles of 56 inch pipe laid by the Board of Water Supply as part of the
4365 new line through Brooklyn, the auxiliary cost 42%. For 2 miles of 66 inch pipe, being another section, the auxiliary costs were 57% of the primary items, running very much higher for city work than for outside work. I have simply cited these instances to show the substantial nature of this addition, and also to make perfectly clear that it bears no relation whatever to overhead allowance; they are actual cash expenses for things that have to be done in connection with the pipe.

Questioned by Master.

4366 I have the costs on the line that they have been laying out through the park recently, but they would run much higher, and I do not think that is comparable as it would lead us to a much higher percentage, because that was a very crooked line through the park, and there was a great deal of extra special work on it. That was a

short line, done under special conditions, and I should not give it nearly as much weight as some of the lines that I used.

DIRECT EXAMINATION BY MR. GREENE.

It is not always fair to take the cost of reproduction of the materials that were actually used as a final measure of value, and that is particularly the case where there has been changes in the art, where conditions have changed, and where some other material would be used in place of the original material if construction were to be carried out at the present time. Steel pipe has very largely replaced wrought iron pipe in the large water pipes that are being built by the cities of the United States. I made an inquiry as to 4367
the possibilities and probable costs of replacing these lines with steel instead of wrought iron with which they are actually built. If they are to be replaced with steel, they would have to be of greater diameter to have the same carrying capacity. The tests of these old lines show an actual carrying capacity of water 13 or 14 percent greater than could be reasonably expected from steel pipes of corresponding age. To equalize the steel pipe with the wrought iron pipe 5% added to the diameter would give the 13 or 14 percent increased carrying capacity. In considering replacing with steel I assumed that the steel pipe would be 5% greater in diameter than the actual pipe used. The steel would need to be thicker than the wrought iron, and would need to be 5% thicker to maintain the same relative strength with the increased diameter. But that would not do. The steel pits and steel pipe lines that have been for a considerable number of years in service, made with plates nearly always a quarter of an inch thick, or frequently thicker, have become perforated by pitting in considerable numbers. That has happened at Rochester, Cambridge, and at Portland, Oregon, and it has happened pretty commonly where steel has been used. In replacing the wrought iron with steel, it would not do to use these thin sheets, and I have figured on using the thicknesses of plate that I should ordinarily figure for that service. That would be a mini- 4368
mum of ¼ of an inch, and I would not use less than ¼ of an inch plate anywhere. I have made the steel plates, with one exception, at least 1-16th of an inch thicker than the present plates, and where the present plates come between the 16th, I have gone to the next thicker size. The one exception to that was in the case of one line of 30 inch by 5-16 pipe, which I figured on replacing with steel plates of the same thickness, because I thought 5-16th was thick enough for that particular service.

I further assumed that the steel to be used in replacing the pipes would be taken from the bottom of the ingot, inspected at the mill on both sides of the sheet; that it would be manufactured in a workmanlike manner, and dipped with as good dip as the Spring

Valley dip, and otherwise laid in the same way as the Spring Valley pipes. I have a table which shows in very concise form this comparison, and I put, in two parts of the table, first the size of the present pipe and its weight as steel, and cost per foot, and on the second side I have written opposite the diameter and thickness of the steel pipe, which I took for comparison with it, the weight per foot, the cost per pound, and the total cost per foot, and the dif-
4369 ference. That is, representing whether it is more or less than the estimate that is written into this schedule.

Questioned by Mr. Searls.

The column "Weight per foot as steel" means that is the weight of a steel pipe by the formula that I usually use for a pipe of those dimensions. It does not mean the actual weight of the Spring Valley pipe. The weight is of steel pipe, but this is the estimate for the wrought iron pipe which was laid last year, and which is written into the schedule. The weight per foot as steel means that a steel pipe 54 inches in diameter, and 0.275 inches thick, would weigh 196 lbs. to the foot. The 275 pounds on the righ-hand side is for a pipe 56.7 inches in diameter, and $\frac{3}{8}$ of an inch thick. In the first item, the large pipe extends in the estimate to 15.80 per
4370 foot. To replace it with steel, according to this estimate, which I submit as a perfectly fair one, it would cost 15.70. The next item 44 by $\frac{1}{4}$ inch, which is the Crystal Springs pipe, is 11.90. To replace it with steel would cost 12.50, or 60 cents per foot more, and so on down through the list. To replace a pipe with steel in this way would cost more by a substantial amount than the figures which I have used.

(Witness advised that in the fifth column under "size, inches" the figure 42.6 should be 46.2).

This table marked "Plaintiff's Exhibit 98k".

DIRECT EXAMINATION BY MR. GREENE.

The increased diameter of the steel pipe is figured so as to equalize the carrying capacity. We are figuring on old pipe, and the intention has been to increase the size of the pipe to the extent as nearly as possible to give it the same carrying capacity at the same age.

4371 Questioned by Master.

The wrought iron pipe is preferable, and the prevailing practice of using steel is because it is much easier to get, cheaper, stronger, and is obtained in very much larger plates.

Questioned by Mr. Searls.

If a system the size of the New York Water Supply should desire to use wrought iron pipe, I do not feel sure that they would find plenty of factories who would be glad to take the job. Making puddled iron depends upon labor to a peculiar degree, and upon a

special kind of labor. It is very hard work, and no machinery has ever been found to do it adequately. The work has to be done in the mouth of a furnace, and the masses of metal to be handled are ordinarily 200 or 300 pounds; they have to be handled with stirrers and appliances. There is a race of puddlers that is not very large, and is perhaps decreasing in number, employed in these works. It would be very difficult from a labor standpoint to take up the manufacture of wrought iron on a large scale today, and I do not believe it could be done. I think we swung from steel to wrought iron too quickly and too completely. There has been more or less 4372
trouble in the corrosion of the steel, and many of the early steel lines are going to be corroded and disappear in time. I think we are going to learn better methods of making steel, and that is the way the better development will come. There are very few men of the type of Mr. Schussler in the country, unfortunately, who are so insistent on what they want, and get what they want. Referring to a sheet marked "Plaintiff's Exhibit 98-1"; contains some statistics of the riveted pipe in the city distribution system and outside, and contains an estimated cost to reproduce laid complete, including ordinary fixtures amounting to $3,975,400. The price of cutting through and replacing the pavement in the city distribution system and outside are all listed in the schedule under several items, and all amount to about $84,000; then there were the Seventh Avenue Tunnel, which has nothing to do with the pipe, but was grouped with it in the schedule, and I have carried it along as a matter of 4373
convenience. There are allowances for obstacles such as the added cost of laying in city streets over and above the cost of laying outside, which is covered by the price per foot, and outside there is also an allowance under that head of 70 cents per lineal foot for all of the pipe laid along the main state road, to cover the added cost of work along that road. There is an item of $1,850 for specially difficult delivery of certain syphons up on the side of the mountain. For trestles and auxiliary there is $150,000. The pipe laid across near the bay, the trestle is in a very hard position to deliver to; the ground is soft, and it is not possible to get teams directly to the place where the pipe was laid. Delivery was made on the right of way of an old railroad, and was got across to the trestle across a moat of intervening water. The operation of delivering the pipe there represented considerable difficulty, and I consider that the difficulties of delivery offset the ordinary cost of excavation, and estimated the same price per foot for the pipe on the trestle that I estimated for the pipe in an ordinary trench, and then the estimated cost of the trestle which appears in the schedule, and is an additional amount.

Questioned by Mr. Searls.

Those conditions were at Ravenswood, and I did not need any

4374 information as to them, as I could see them. I am speaking of the section from the beginning of the trestle to the point on the Dumbarton Bridge on the Alameda side.

Referring to a memorandum of auxiliary structures, it was
4375 marked "Plaintiff's Exhibit 98m".

My first experience with riveted pipe was about 1897, when I designed about 8200 feet of 48 inch pipe as part of the Albany-New York Waterworks System. I was aided in this by Mr. Emil Kuichling, of Rochester, N. Y., who was the leader of all the men who had to do with riveted pipe in the United States, and I should rank him with Mr. Schussler in that respect. He had done work on riveted pipe as an assistant of Mr. Tubbs, who had been responsible for some of the earliest lines in the United States. As Mr. Tubbs' assistant, he had aided in the construction of a number of early lines, and in time had succeeded Mr. Tubbs and built other lines on his own account. He had managed the Rochester Water-
4376 works, and had the maintenance and upkeep of the several lines of riveted pipe that were there used. He had also been engaged on the East Jersey Water Co.'s pipe, the most important riveted pipe perhaps laid in the United States up to that time. Mr. Kuichling was a student, and he had mastered the subject, and he put all his information at my disposal. He helped me also from time to time on other difficult lines as long as he lived. From that one, I have made estimates for riveted pipe repeatedly in connection with various waterworks projects, and built quite a number of them. Among the more important ones, the riveted pipes at Washington, and about 12 miles of pipe at Springfield, Massachusetts, as part of the new system. I also designed a line of 48 inch pipe 16 miles from Portland, Maine, but that work was done at a time when there was some excitement about the perforations in the Rochester and other early pipe, and the trustees decided to use cast-iron pipe, even at an added cost of 50%. I have seen many of the principal pipe lines in this country, and have been familiar with the methods that have been employed, and also to some extent with foreign work, and have followed the matter very closely from the first up to the present time. I made estimates for Winnipeg, but was not connected with the construction. I also made estimates for Ottawa, and was responsible for one line of pipe that was laid in Ottawa a few years ago.

4377 In the case of the Pleasanton line Mr. Lawrence had a record of the actual cost. It was made up in part of new pipe, and in part of the old Pilarcitos pipe which was taken up, cleaned, re-dipped and re-laid, and in that schedule of costs the Pilarcitos pipe was put in at the same price per foot as the new pipe which was bought for use in connection with it. I went through that record, and I used the actual cost for that line in place of the estimates. There were

a few other lines, steel lines, and the slip joint lines near Merced, that were estimated on the basis of what the pipe would cost, and the approximate cost of laying, including the re-laid pipe that was used, and then there were a few lines where a great many kinds of pipe were used in one line. On one of the lines to Ocean View where various kinds of old pipe were used to avoid buying new pipe, I did not estimate each section of that pipe, or what it would come to by the price per foot by the methods that I have described; instead I looked at the line broadly and said "It is equivalent to a line of such a size and such a thickness" and estimated it in that way, and getting a result in that way less than would have been reached by applying the separate prices to the separate sections. I think there 4378
are a few places where, when I was taking up the work, we multiplied it out on the slide rule, and I remember in one of the first items the siphon when we got through we added something for the extra delivery, because it was a place up on the side of the mountain that was extremely difficult to get at, and I went over that with Mr. Lawrence, and added what I thought was fair for that, and that was written in as a lump sum instead of the price per foot. But those represent in the aggregate a very small percentage of the schedule. Referring to page 4, item 25, 730 lineal feet of pipe; that is the case that I have just spoken of. That is carried in as a lump sum, $8,150, and to that I have added as not being a part of the normal price of pipe, concrete piers, and some redwood and steel, bolts, etc. Referring to page 21, structure 7; that is the San Andres pipe line; 44 inch, riveted, wrought iron pipe, No. 7, 2,044 feet, at $10.40, $21,258.

Dillman's total on item 11, page 21, $278,653, to which he has 4380
added 10% overhead, making a total of $306,518. Mr. Dockweiler has $267,934; the overhead will have to be added on separately.

The Master: You are $90,000 apart. 4381

Mr. Dillman: Hazen is $474,000, and mine is $321,000; to that particular item I have added Hazen's overhead and my overhead, and Hazen's is 28.8 percent, and mine is 15½ percent. There are three pipes there. Mr. Hazen's prices are $10.40, 11.90 and 8.80, and something should be deducted from Hazen's for his extras. Dillman is $7.25, 8.60, 7.20, and something should be added to that for excavation and backfill; Dockweiler's is $6.38, 7.95, and 6.68, to which something should be added for excavation, extras and backfill.

Mr. Hazen: The excavation is not included in the 10 percent, and these items that are omitted, except excavation for a large 4384
part, perhaps altogether, are included in that 10%, but I also think that there are a great many other items of cost that had to be incurred in laying these pipes that would not be incurred in laying pipes that are not represented in this schedule at all, but are representing my unit price. I have intended to cover the cost that would actually be met in construction.

Mr. Dillman: Referring to structure 11, I have six items there; the 44 inch riveted wrought iron pipe No. 7, 2,044 feet. The schedule is the same. My price is $7.25 for the 44 inch; ¼ inch thickness 26,851 at $8.60, $230,919; 37 inch pipe ¼ inch thick at $7.20, and
4385 the trenching is added 39,000 yards; that is according to the schedule at 50 cents, and the extras as per schedule I have not covered, $2,795, making a total of $278,653, to which I have added 10 percent. The figure of Mr. Hazen, of $368,000 odd, corresponds to $278,000 or nearly $90,000 difference. He has a total overhead of 28.8 percent, and I have added a total overhead of 15½ percent. I have a cost on one of those lines of $7.25 per foot, and that unit occurs else-
4386 where in the schedule.

SIXTY-THIRD HEARING. NOVEMBER 18, 1915.

Witnesses: ALLEN HAZEN, for Plaintiff.
W. B. LAWRENCE, for Plaintiff.
GEO. L. DILLMAN, for Defendant.
J. H. DOCKWEILER, for Defendant.

Questioned by Master.

4387 Referring to page 18 "Plaintiff's Exhibit 98j": The figure $3,951,531 is my last years figure, and the figure $3,978,835 is the
4388 result of my later studies. The smaller figure is obtained by multiplying the base price by the length in each case and adding them up; in the items in the schedule there are some additions for a number of things, but I did not sort them out. If the schedule were assembled in the same way this has been, the discrepancy might be eliminated.

Referring to "Plaintiff's Exhibit 98-l", "Summary of main lines of riveted pipe"; the figure which is comparable to the figure $3,978,-835 is the figure $3,975,400 on the last table. The multiplications were all made by approximate methods, and from the standpoint of estimating, I considered it a sufficiently close check. The figure of 75 cents per cubic yard for excavation, earth and rock, is a very broad classification, and would actually include some sand, and here and there some mud, but not very much mud. That figure is based
4389 on my general experience with public works primarily; in my judgement it is the fair figure for all the work in this case. A little over 2% of all the material was rock, as shown by the agreed schedule. As between the sand and the material that is classed as clay locally, but which is not clay, but more of an adobe, I should say that there is no difference in cost of excavation in pipe laying that would warrant making any separate figure. Through the material that is called clay, a comparatively narrow trench can be cut in dry weather and it will stand; it will cost more per yard to excavate it, but the ma-

terial stays there until you get through, and there is very little trouble with it. In a sandy trench the digging is very much easier, but one has to brace it a good deal, or else the sides slide in, and you handle a great deal more material. I should estimate the cost of laying just the same through one material as through the other, and those are the two principal classes of material outside of rock.

I have a little supporting information from the Spring Valley's experience as to the cost of that excavation. To answer your question of yesterday about supporting evidence for the auxiliary structures: The only line where there was a chance of getting that was on the 54 inch Alameda line, and there is a record of some $6,000 or $7,000 that clearly would go into that item from the labor standpoint, on the Lawrence notes, amounting to perhaps 3% of the cost of the 4390
pipe, but there are no corresponding items of materials that must have gone with that. The total schedule made up from the Lawrence notes falls short by perhaps something like 10% of the reported cost of the pipe line, so it is evident that that is not a basis that can be used in discussing that item. I do not know of any other important lines that there would be any chance of getting that information on at this time, and I am sorry I cannot support that from Spring Valley records. Referring to the excavation, I checked the quantities in the agreed schedule with the quantities I usually use for trenches for these sizes of pipe, and with these materials as I saw them, and I checked very closely; I was entirely satisfied that the agreed quantities were true. The rock excavation is 2.15 percent exactly of the whole amount according to the agreed schedule. The Alameda pipe line, laid in 1888, was done under a contract with the Risdon Iron & Locomotive Works. They received 26 cents per lineal foot for excavation; for back filling and tamping, 17.4 cents per lineal foot, and in addition, $1 each for joint holes. I estimated that the $1 each for joint holes amounted to 3.6 cents per lineal foot, making the total cost of the excavation under that contract 47 cents per lineal foot. The yardage on that line I take as 1.15 cubic yards per lineal foot, and at 75 cents per cubic yard, the figure which I used, that would amount to 86 cents per lineal foot, whereas the contract price in 1888 was 47 cents. Prices in 1888 with low labor, of course, 4391
are not much indication of present costs, but I give it for what it is worth.

In 1903 the 54 inch Alameda pipe line was laid, and there is quite a full record of the cost of excavation. That amounted to $40,921, equal to $2.44 per lineal foot. The excavation I estimated at 2 yards per lineal foot, so that the cost was $1.22 per yard; that includes the backfill. The road work was estimated separately by Mr. Lawrence, and is reported as costing $3,603, or 22 cents per foot. I do not believe that the classification between excavation and the extra cost of the road work could have been adequately made by

Mr. Lawrence. I think that some of the extra cost of excavation was due to the fact that the work was done along the public road, and some of the allowance for that is in his excavation, and not in the item which has been separated, so that the total actual cost of those two items, putting them together is $2.66 per lineal foot. My estimate is for 2 yards at 75 cents, $1.50, and I added for extra work, because the work was along the State road, 75 cents per foot, making $2.25, as compared with the $2.66 actual cost. I think I gave the dimensions as my own, and not as Mr. Lawrence's.

DIRECT EXAMINATION BY MR. GREENE.

I reduced Mr. Lawrence's figure to a per lineal foot basis, and gave the total cost, and then the cost which I obtained by dividing
4392 it by the length of the pipe. I can give a little other supporting data from Portland as a matter of interest, but I think it may be open to doubt if the Portland material is just the same as the San Francisco material. I have Mr. Clark's records, and I attached some significance to them. For the steel pipe laid in Portland in 1894, most of the soil being of an adobe character, called in Portland, as it is here, clay, but not being a true clay—I examined that personally, and satisfied myself as to its character—the cost of the excavation for the first complete line, including backfill, was $130,700. That amounts to 76 cents per lineal foot. The average size of the pipe was 37 inches, and I estimate for 37 inch pipe in the Spring Valley estimate, which would be as far as I know, the same as it would be for Portland, 1.18 cubic yards, and that at 75 cents is equal to 88 cents per lineal foot; in other words, the actual cost in 1894 was 76 cents, whereas the figure at the price I use in this estimate would be 88 cents. For the second Portland line, laid in 1911, and therefore being done practically at the present time, and at present prices, the excavation cost $192,726. That was for 128,500 feet, or $1.50 per foot. The average size of the pipe was 46½ inches; 1.58 cubic yards per foot being my estimate of the yardage on the same basis as the others at 75 cents per foot, $1.19. In other words, I would estimate $1.19, whereas the actual cost was $1.50. Both of those pipe lines were known as the Bull Run Pipe. I think I made an error in the cost of that first excavation. I gave it as $130,700, which was
4393 the length of the pipe. The cost was $99,384.

I have a preliminary statement from Mr. Elliott, of the cost of the pipe through the park, and there were 3,203 feet of 30 by ¼ inch pipe. The weight of the finished pipe, as I usually estimate it, was 104 pounds per lineal foot. My price for steel pipe would be 6½ cents laid, including everything, and at 104 pounds per foot, that would be $6.75, which for the distance amounts to $21,600. That is estimated at the unit prices that I ordinarily use in an estimate. The actual cost, as Mr. Elliott has it, was $23,250, not including

overhead, and with perhaps some items not finally adjusted. Mr. Elliott tells me that the difficulties on account of the park were comparatively little, and he thinks much less than they would have been along the State road, so perhaps to use the estimate that I made for the extra cost along the State road, on the peninsula, would be too much to use. That was 75 cents per foot, and if it were all applied to this length, it would amount to $2,400, and adding that to the first item, it would bring it to $24,000. The actual cost falls between the two figures on the preliminary statement, so that it 4394
seems to check pretty closely with the figure I am using. However, there are two things that ought to be taken into account; the steel was taken out of stock, and was charged at a higher price than the current price of steel, while on the other hand, owing to the business depression, work of this kind has notoriously been done during the early part of 1915, at prices that are very much below ordinary normal prices.

Questioned by Master.

Apparently the park job did not differ from the outside work as much as it was my impression yesterday. I did not see the work under way, and I have to speak with that qualification. It is a small job, and it is to be considered for whatever it is worth. I should not attach any great importance to any one job of that size, as fixing the price of material in a large system, or fixing the normal price that would be fair under average conditions.

Questioned by Mr. Searls.

I got Mr. Clark's report of actual cost on the Portland job. I do not think I estimated the yardage in Portland. I stated what the yardage would be for that size pipe, as I have estimated in the Spring Valley system, and multiplied that by 75 cents per cubic yard, 4395
and got the price per foot, comparable to the cost per foot which Mr. Clark reports for the Portland system. I got at my divisor by taking the total length. The contract price for the 1911 work for the excavation was 70 cents per cubic yard, but there was some extra work, so that I think the whole cost of excavation was more than the contract price multiplied by the yardage.

Witness: W. B. Lawrence, for Plaintiff. Lawrence

DIRECT EXAMINATION BY MR. GREENE.

I have kept records of costs of certain of the work done by the Spring Valley Water Co., but there is not included in those costs the overhead costs, or the office costs in the city. The set of schedules entitled "Analysis of Data Upon Original Cost, and Cost Under Original Conditions, But Present Prices of Riveted Pipe, W. B. Lawrence, October 1, 1915", were prepared by me, or under my

direction. The sheet marked "P1" contains the iron furnished to
4396 the Spring Valley Water Co. for the Crystal Springs pipe line, Alameda pipe line, San Andreas pipe line, and the Merced branch of the San Andres pipe line. The columns from left to right is the data, the contractor, the size of the pipe, the length, the total weight in pounds, the contract price per pound in San Francisco, the amount, and the weight of plates per lineal foot of pipe. The sheet marked "P2" gives the price of the rivets delivered, and the line where it says "pipe" should be cut off right after the letter "s". The weight of the rivets, and not the weight of the pipe, is the weight given, and it gives the name of the pipe line, the date, the contractor, the size of the pipe line, the length, the weight of rivets, contract price, the amount, and the weight per lineal foot of pipe. The weights that are marked "Theoretical Weights" were taken from specifications; weights of other items were taken from memorandum of bills, and so forth, in the records of the Water Division.

The figure $68,771.49 at the bottom of the tabulation divided
4397 by $991,739 gives an average of .0688, which is the price of the rivets, and not the pipe. On the sheet marked "P3" is the contract price of iron rivets obtained from Sheets 1 and 2. Apportionment of weight of plates, and rivets per foot of pipe: Crystal Springs pipe line, Alameda pipe line, San Andres pipe line, San Andres-Merced branch, giving the average cost of plates and rivets per pound of pipe undipped, 4 cents.

Sheet marked "P4" is the cost of making and laying riveted wrought iron pipe, exclusive of cost of metal. That gives the date, contractor, size, length of pipe, weight, the contract price per foot, amount, and cost per pound, giving a cost of .0291 as the average cost per pound of pipe undipped. This contract price, and average contract price, represent the cost of fabricating the sheet metal into pipe, and laying and riveting the pipe in the trench. It does not include the cost of patching bad plates, slivers or flaws, cartage to and from contractor's mill, and sundry other incidental costs, as well as costs of dipping, earth work, storage of iron and rivets, and re-handling involved. The weight here used is computed from the tables on "P32, 33 and 34", those tables being an estimate based on the average weight of 59.14 tons of pipe, varying in diameter from 54 inches to 18 inches.

4398 Sheet marked "P5" shows asphaltum coating for wrought iron pipe. Pipe is coated with a refined mixture of asphaltum and coal-tar in the proportion of one 50 gal. barrel of coal-tar to 1400 pounds of crude asphaltum; one barrel of coal-tar weighs 470 pounds, hence the proportion is one part coal-tar to three parts asphaltum. That gives an average cost of .008 per pound of material for coating.

Sheet marked "P6" is the actual cost of dipping 7,784 lineal feet of 30 inch pipe from San Andreas line, exclusive of overhead

and interest. In the first column I had a day of 10 hours; in the second the rate of wages as of 1902, and in the third the total amount. The last three columns show, first, the day reduced to an 8 hour basis; second, the 1913 rate of wages; and in the next column the amount based upon an 8 hour day, and based on the 1913 rate of wages.

Questioned by Master.

Referring to the question mark as to 1902, I think we questioned that foreman on the $6 item.

4399

Questioned by Mr. Searls.

The item "Blasting stumps": We cut our own trees for firewood for firing the kettles, heating the asphaltum, and that is the cost of that. Stump blasting is not any part of the manufacture, but it was a cheaper way of obtaining the wood for heating the asphaltum. We had to clean the place up, which explains the necessity of blasting the stumps. That amounts to the sum of $12.50.

Sheet marked "P7" shows the cost of asphaltum coating for wrought iron pipe. The cost for coating on pipe, estimate, exclusive of overhead and interest. The cost of dipping pipe with Schussler Coating, has been 1 cent times diameter in inches per lineal foot of pipe, exclusive of overhead and interest. It is a little bit more than that, but we have adopted that. On the 54 inch pipe, it brings it up to 64 cents; on the 52 inch it goes about 63 cents. (Counsel for Plaintiff called attention to the fact that that supplies the justification for the figure which Mr. Hazen and Mr. Dockweiler agreed upon).

4400

Sheet "P8" shows the cost of handling pipe, and we have the last two moves from the railroad cars to the wagons, and from the wagons to the trench. We haven't it from the factory to the dipping works, and from the dipping works to the railroad cars, but we have assumed that at the same rate.

"P9" is the freight in 1913 on finished pipe from San Francisco. We are informed by the railroad agent that there is not very much variation from several years previous.

"P10" is the actual time and cost, exclusive of overhead and interest of the San Andres 44 inch pipe, screen-tank to Baden, and then expanded to 1913 hours and rates. We have the total for 1898 on the next page. From my data I could not designate and carry out for example 521¼ days at $2.50 and at $5.30, but I have the total. The last column on page 11 is the distribution of general cost; that was the foreman in charge of the works, and several other items that could not be applied to any one of the following items; I am referring to the $11,000 item. The next line means that $43,814 is 46.4 percent of the estimated cost of $105,000. This shows that between 1898 and 1913 these costs advanced 80%.

4401

"P12" labor cost installing 16,757.1 feet of 54 inch pipe. The contract included the fabrication, riveting, and the putting of the

pipe in the trench. All other work was done by the Spring Valley Co.

"P13" is the labor cost, exclusive of overhead and interest, installing 16,757.1 feet of 54 inch pipe, continued from other page. "P14" is a continuation.

4402 "P15" shows the 36 inch Alameda pipe line, No. 7 iron, through the Ellsworth property, laid in 1900; the actual time, and the resultant cost from application of 1913 labor prices, exclusive of overhead and interest. I have not given the 1900 rates there, but I have the days.

"P16" and "17" show the actual time and the resultant cost on the Stone Dam Aqueduct, 44 inch pipe line, 2,109 lineal feet, 44 inch by 3/16 inch pipe, actual time and resultant cost from application
4403 of 1913 labor prices, exclusive of overhead and interest.

"P18" is the Millbrae pumps force-main 30 inch pipe, 7,445 lineal feet, 30 inch pipe, ¼ inch metal, actual time and labor, resultant cost from application of 1913 labor prices, exclusive of overhead and interest.

"P19" shows San Andres new pipe, 44 inches by ¼ inch, 1897, 1898. It is an abstract from contract with Risdon Iron & Locomotive Works for accessories to 44 inch pipe line. The accessories include elbows, reducers, laying the elbows, straps put on, courses of 44 inch pipe, 5/16 inch iron, 44 inch ell near screen-tank, 5/16 iron pipe for Baden Crossing, and laying the same. It includes bends, bands, straps, man-holes, blow-offs, and air valves, but does not include concrete in trench, special foundations, or allowances for obstacles or gates. They are not the same figures, and do not cover everything that Mr. Hazen's allowance for accessories did cover.
4404 The next is the accessories on the Alameda 36 inch pipe line, which are actual costs as of the date when they were laid, and do not refer to 1913.

"P20, 21 and 22" are continuations. "P23" is the final summary. "P24" is the cost of pipe per pound, exclusive of overhead and interest. In the last column marked "Accessories" they include the accessories to which I have referred.

Questioned by Mr. Searls.

That is the old pipe cost, laying it on the basis of 1913 wages. The material prices are present day prices, too. The materials represent the average of what we actually paid.

4405 DIRECT EXAMINATION BY MR. GREENE.

"P25" is the cost of wrought iron riveted pipe per lineal foot, exclusive of overhead and interest, and that is the same table reduced to a per lineal foot basis. "P26" is the Pleasanton-Sunol pipe line. It is a different class of pipe from what we have used heretofore in our other lines, and the purpose of these figures is to show

why I did not carry the data as to this pipe into my prior tables. It shows less. It is riveted differently, and put together in the ditch differently, and could not be used consistently with the tables in our other lines.

"P30" shows a table of actual weights of wrought iron pipe computations to determine the value of "C" in formula "W" = C (d x t)—from the records of the dipping house. This formula was suggested by Mr. Hazen. "C" stands for coefficient, and reduces 4406
the form here by 12.38. It is in the bottom line. "P35" is the Merced branch of the San Andres pipe line, actual time and cost of 1907, and the resultant cost from the application of 1913 labor prices, exclusive of overhead and interest. The sheet marked "P36" is a continuation of that. "P37" is the cost of excavation and backfill, pipe trench, summary, exclusive of overhead and interest. I got the cubic yardage in the fourth column from our profile, and the fourth column gives the cost per cubic yard, which is determined by reference to the sheet marked "P11", and is the total costs taken from my records at Millbrae.

Mr. Hazen: I understand that the figure of $1.52 is comparable with my figure of 75 cents, but I have not studied these figures.

Mr. Lawrence: The sheet marked "P-37a" is the cost of the Baden connection of the Merced branch of the San Andres pipe line near Baden. The figures which I have given are taken from the 4407
records to which I referred in the first part of my examination, and they represent the actual expenditures made by the company, and on account of the items referred to in these schedules. There may be some other costs that I know nothing of. This represents a minimum expenditure, and I am not in a position to say whether it also represents a maximum expenditure or not.

Questioned by Mr. Searls.

The 1913 wages that I have given are not in all cases the regular union scale; the union scale was higher in some of the cases than I have estimated here.

Questioned by Master. 4408

For ordinary labor it is the union scale. The union labor scale in San Francisco is $3 a day, and in San Mateo County it is $2.50 a day. I used $2.50, and am paying for ordinary labor $2.50 in San Mateo County.

Questioned by Mr. Searls.

I think on teams that the company pays less than the union scale. We pay $5 a day for carpenters. If the company had to do this work today, the 1913 wage schedule would not be cut.

Questioned by Master.

My two-horse teams I have estimated at less than the union scale, as I believe the union scale on that is somewhat over my $6.

Questioned by Mr. Searls.

In San Mateo County we observe the 8 hour day in all our work. In Alameda County, on the pipe line and so on, they are working 9 hours a day at present. If you would put on a large force to do this work, you would not be permitted to work 9 hours a day. I do not know of contractors today working on large jobs 9 hours a day both in Alameda and San Mateo Counties. If I were rebuilding this 54 inch pipe in 1913 I do not think I could obtain the teams as cheaply as I have estimated here. The carpenters we could get for $5 a day—they would quit at noon on Saturdays, and I have estimated that as a whole day. If you had a good sized job, you would not be able to run it into 9 hours in San Mateo County, and I do not think you could in Alameda County near a railroad or any town.

4410 These records were kept under my supervision from which my figures were taken, and the time-keepers kept them for me. I did not get all the duplicate bills on this material cost from the company. They came to me, you might say, in duplicate bills, memoranda, and original bills.

These sheets from which Mr. Lawrence testified were introduced and marked "Plaintiff's Exhibit 99".

The volume from which Mr. Hazen testified will be marked "Plaintiff's Exhibit 98 and 98m".

Dillman Witness: Geo. W. Dillman, for Defendant.

4411 DIRECT EXAMINATION BY MR. SEARLS.

The probable cost of any construction depends upon some assumption, and the more complicated the job, the more numerous the assumptions. This is the most complicated problem of the kind I ever heard of. My experience has been along actual construction lines, and therefore my point of view is not wholly that of an en-

4412 gineer, as I have also been to some extent a contractor. Work is done by a contract according to specifications; there being no specifications here. I have assumed that they are not onerous, and that requirements will not be more expensive to the contractor than necessity requires. In this respect I am in the position of an engineer for the company. This may not seem important, but it is important in the cost of the work, the difference between what may be termed fair and rigorous specifications, reasonable and finnicky, supervision and inspection, friction instead of smoothing out and helping on the part of the engineer of the company, can easily make a difference of 25% in the cost of most of this work. I have assumed that managers of contracts are honest, able and industrious, and supervised by an executive of high order. The difference in cost between an efficient organization, and only slightly less efficient, may be 50% in ultimate cost. In this I have taken the viewpoint of the con-

tractor. These points of view and assumptions will result in as many estimates as there are estimators. I do not want to have it assumed that I know all about these various questions, but I do know something about all of them, and the estimate is what I should take, or advise clients to take a contract at, under the assumptions made. I would consider it as a whole a splendid contract with my prices. I would consider any portion of it a good contract with my prices, but I would not consider the whole or a part of it a contract to be taken if it had to be done with antagonistic supervision.

Steel is a common material today of which riveted pipes are made. Wrought iron is not. Steel is stronger, while wrought iron can be worked easier, especially in punching and calking. I have never laid any wrought iron pipes, but I think the steel today is milder, softer, and more nearly approaches wrought iron in its composition than a few years ago. When pipes begin to rust, the steel will rust faster than the iron pipes, and the purer the iron the slower the rusting, but the life of these pipes, both steel and iron, depends a great deal more on the coating than on the composition. 4413 4414

I have not received any quotations on either steel or iron pipes recently, but this estimate is based on the costs of pipe manufactured, coated and laid alongside the trench at 5 cents a pound, or $100 per ton. If the sheets are bought, they are bought by the long ton, and that 12% accounts for some loss in manufacturing. $100 a ton for manufactured steel pipe alongside the trench is somewhat more than would be paid for steel during the period from 1907 to 1913. I assumed that it was enough to buy wrought iron pipe. If there is only one manufacturer of wrought iron pipe in the United States, and he knew that the specifications required wrought iron for the job, I would probably be held up to a certain extent unless I could develop some competition in making the purchases. In making my estimates I did not assume that there would be only one manufacturer, and I have always supposed that there were two well known manufacturers, and I consider it a reasonable assumption to make that other mills would turn their energies in that direction for a large contract. I think the most of the Spring Valley pipes were originally laid in the days before the steel industry had been fully developed. In recent years I have not heard of any wrought iron pipe being laid on any jobs of considerable size, outside of San Francisco. 4415

The only difference, so far as the life of the pipe goes, is in the rate of rusting after rusting begins and the coating is destroyed; as long as the coating is intact the pipes are permanent, and there is no question in my mind but that the long life and excellent condition of the Spring Valley pipes today is due to a great extent to the coating with which they were dipped rather than to the material from which they were fabricated. I have estimated a reproduction cost on wrought

iron pipe, and as a basis for the figures I used, I prepared a table showing the cost of the different sizes and thicknesses of wrought iron pipe which are found in this system. The table follows:

4416

RIVETED PIPE—PER LINEAL FOOT.

Size	Joints	Thickness	Wt. per ft. lbs.	Cost at Trench (5c)	Lead (6c)	Laying	Constant	(50c) Exc. & b. f.	
12″	Lead	No. 12	15	.75	.10	.11	.96	.24	1.20
22″	Lead	No. 7	47	2.35	.20	.25	2.80	.35	3.15
22″	Riv.	No. 9	38	1.90		.56	2.46	.34	2.80
30″	Riv.	¼″	86	4.30		.90	5.20	.45	5.65
30″	Lead	No. 3	93	4.65	.27	.45	5.37	.43	5.80
30″	Riv.	No. 12	37	1.85		.90	2.75	.45	3.20
30″	Riv.	3-16″	63	3.15		.90	4.05	.45	4.50
33″	Lead	No. 3	101	5.05	.30	.60	5.95	.50	6.45
36″	Lead	3-16″	75	3.75	.32	.75	4.82	.53	5.45
36″	Riv.	No. 9	60	3.00		1.20	4.20	.55	4.75
36″	Riv.	¼″	97	4.85		1.20	6.05	.55	6.60
37½″	Lead	No. 3	116	5.80	.33	.80	6.93	.57	7.50
37½″	Riv.	No. 3	116	5.80		1.40	7.20	.60	7.80
37½″	Riv.	No. 7	78	3.90		1.40	5.30	.60	5.90
44″	Riv.	¼″	125	6.25		2.38	8.63	.72	9.35
44″	Riv.	No. 7	97	4.85		2.38	7.23	.72	7.95
44″	Riv.	No. 6	102	5.10		2.38	7.48	.72	8.20
44″	Lead	¼″	125	6.25	.40	1.50	8.15	.70	8.85
54″	Riv.	5-16″	195	9.75		3.50	13.25	.90	14.15

To explain the table: I got a line of the sizes, the kind of joints, 4417
and the thicknesses of pipe, and from an old chart of mine I computed the weights. This chart was made in 1893, I think, and so far as it is applicable, the fourth column of my table, weight per lineal foot, came from this chart. I did not know there was a Hazen formula, or I would have used it, although there is not a great deal of difference. There is some difference in the lighter pipe, but the difference is not very serious. On that weight I have assumed 5 cents a pound alongside of the trench. Lead joints were used in some cases; prices for laying, putting together, and putting in the trench—that gave me a constant which was used either in addition to the excavation and backfilling, or the cost of trestle in other cases. The final column is the cost of the pipe laid and covered. The figure 50 cents at the head of the column, entitled "Excavation and backfilling", signifies that is computed at 50 cents a cubic yard for an assumed amount of excavation. The column headed "Constant" means the sum of the three previous columns, and in some cases four. In estimating trenching cost, I used 50 cents for ordinary excavation, because it was ample to cover in my experience. I used a higher price where rock is noted in the inventory. The last contract I let for excavation and back-filling of this kind was for water pipes and sewers in a little 4418
town in Stanislaus County, probably altogether 12 or 15 miles of it. Some of the trenching was 15 feet in depth, and was at a much lower price. My original estimate was 40 cents a cubic yard, and the successful contractor took it at 26 cents per cubic yard. No other bid was above my estimate of 40 cents. The trenching cost for the Contra Costa Pipe Line from the glue factory to San Leandro for an 18 or 20 inch pipe was considerably less than 50 cents.

The cost per cubic yard would not be greater where you are laying a 54 inch pipe than if you were laying a 44 inch. The contract for excavation and backfilling for these pipes can be let, if the work were to be duplicated today, or at any time within the last ten years, at 50 cents or less. The figures for leading and laying are what I would be willing to take a contract to do this work for, or would recommend to a contractor client, and they would turn out a good profit at the end of the job under proper management. Referring to the pipes which I have supervised the laying of, I have never found those costs exceeded the figures which I have placed here in ordinary excavation. I don't remember of any laying costs that are higher than these, but I have not been a collector of data for many years. I did keep
a lot of data, principally contract costs, for many years prior to 1900, 4419
but they were burned up in 1906. This cost does not include the auxiliaries incidental to any particular part of the system.

Referring to page 6 of my appraisal; the unit cost for the 44 inch No. 7 pipe was $7.25, and in this list of mine, the constant is $7.23. This estimate is not figured down to cents. The next item 44 inch

riveted pipe, ¼ inch, I have put in at $8.60. The item is $8.63; I do not know why I cut off that 3 cents; I should not have done it. The
4420 next item, 37 inch riveted pipe, ¼ inch, $7.20, No. 3 and ¼ inch are the same. The trenching is added at 50 cents per cubic yard; the extras $2,795. I got at those extras as I had the original schedule and sized them up in that way. I did not go into much detail with any of the small items, as it was impossible to do it, and it is entirely unnecessary. That price is exclusive of my overhead charges, but includes everything excepting overhead. That works out up to that point on the per foot, or per pound basis, $278,653. The 44 inch No. 7, 2,044 feet, at $7.25 per foot, total $14,819. The 44 quarter inch, 26,851 feet, at $8.60 a foot, $230,919. The 37 inch, ¼ inch pipe, 1,414 feet at $7.20 per foot, $10,181. Trenching 39,878 cubic yards at 50 cents, $19,939. Extras as per schedule, $2,795. Total $278,653. In the column of "Remarks" it says that this figures up $9.20 per lineal
4421 foot of pipe. The figure $8.60, according to the schedule should have been $8.63.

In the inventory and estimate the above is on a per lineal foot basis. The per lineal foot basis starts with the rate per pound, and is reduced to feet for convenience in the computation. I want to say that the weight per foot in my list will vary somewhat from your weight per foot. Mine is based on a diagram that I made years ago,
4422 and have used for such estimates for more than 20 years. I have not computed my total tonnage of pipe. These weights in the table were taken from the diagram I used.

Crystal Springs pipe, item No. 1, structure No. 1: In that case the excavation is added, and the last column is used instead of the constant with the excavation added; the result is the same.

44 inch pipe line No. 7, 6,831 feet, $7.95. 44 inch pipe No. 6, 33,468 lineal feet, at $8.20. The extras as per schedule $12,585. Total $341,330. There is another part of the pipe line which consists of 36 inch No. 7, 297 lineal feet at $5, $1,485.

4423 Questioned by Master.

On my table the cost of trench, 5 cents, is per pound, and the 75 cents per 12 inch is per foot, so that all those right through, except such as may be shown in the heading, are per lineal foot. There may be other items beside the 297 lineal feet. I completed quite a bit of this estimate before I made this table. 44 inch No. 7, 15,308 lineal feet, $7.25, $110,983. 44 inch No. 6, 31,460, at $7.50, $235,950. Extras as per schedule. I have 60,651 yards of excavation at 50 cents, and
4424 the excavation and backfilling total $30,326. Lumber 402,000 feet board measure, at $40, $16,080. Piling, 25,806 lineal feet, at 40 cents. (Mr. Hazen advised that they could agree on that, as he had it at 35 cents.)

4425 Alameda Pipe Line, structure No. 4, excavation and backfill in the trench, 40,397 cubic yards, at 50 cents, $20,199. Excavation upon

cut, 3,261 cubic yards at 25 cents, $815. 36 inch pipe No. 7, 40,464 lineal feet, $4.85, $196,250. 36 inch No. 9, 14,784 lineal feet, at $4.20, $62,993. 36 inch wrought iron pipe, ¼ inch, 251 lineal feet at $6.05, $1,519. Ell straps, etc., as per schedule, $1,000. Bridging 933,000 feet board measure at $40, $37,320. Piling 93,840 lineal feet at 40 cents, $37,536. Other extras as per schedule, $3,112. Total $359,844, or an average of $6.46 per lineal foot. That values the pipe line from Niles Screen Tank to Dumbarton.

Ravenswood to Belmont: Structure No. 24; excavation back- 4426
filling earth, 54,819 cubic yards at 50 cents, $27,410. 36 inch pipe, ¼ inch, 307 lineal feet at $6.05, $1,857. 36 inch pipe No. 7, 18,880 lineal feet at $4.85, $91,574. 36 inch pipe No. 9, 32,455 lineal feet at $4.20, $136,311. Piling 13,680 lineal feet at 40 cents, $5,472. Bridging 124,000 feet board measure, at $40, $4,960. Other extras as per schedule $3,000. Total $270,584, or $5.24 per lineal foot.

Belmont to Millbrae, item 34 structure 34: 36 inch pipe No. 9, 34,376 lineal feet at $4.75, $163,286. 36 inch pipe ¼ inch 55 lineal feet, $6.60, $363. 54 inch pipe, 5/16ths, 16,757 lineal feet at $14.15, $237,112. These prices apparently include excavation and backfilling. Extras as per schedule $7,200. Total $407,961.

Questioned by Master.

My unit on the 54 inch wrought iron pipe was $14.15. Before I made that schedule, I made a good many of these estimates, and I may not have changed a few items.

Questioned by Mr. Metcalf.

I didn't compute the length per foot price. Part of that is 36 and part of it is 54; there is quite a variation in the size of the pipe, and it would hardly be of any value.

Questioned by Mr. McCutchen.

I took the thicknesses of these pipes from the inventory, and I 4428
think I used the United States gage, or the Birmingham gage. They
are very close together for most of these pipes. I think I used the 4429
Birmingham gage, and I think on No. 12 they are identical.

The figure of 5 cents, under the column entitled "Cost of trench 5 cents", was taken from my memory, and impressions of the cost of that kind of pipe at the trench. I would say that it would be divided about 3½ cents on board cars in San Francisco, and 1½ cents for manufacturing, coating and hauling, or about $30 a ton for that part of it. The cost is a little bit excessive for steel pipe; if it is too low for wrought iron pipe, the estimate is low by that amount, whatever it is. At the time I made the estimate, I believed, and I still believe that these figures will do the work. There is not 4430
any fixed price of material at any one time, and all the quotations that one can get from dealers for the purpose of estimating will be cut when he comes to buy the material. For that reason I have paid much less attention to quotations, than if I had not fully un-

derstood that fact, and that applies to all material going into work of this kind. I have not allowed 1½ cents per pound for all of the expense that is incurred up to the time that the finished pipe is put alongside the trench after the arrival of the plates in San Francisco, but I say if I should divide that 5 cents up into other items, I would divide it in about that way. I think $30 a ton is enough allowance for the manufacture of the plates into pipe, the digging, the cartage, and all expenses up to the time that the finished pipe was laid alongside of the trench, and that would be 1½ cents a pound. I would allow for sufficient riveting to develop according to boilermakers' scale about 70 or 75 percent efficiency of joint on the longitudinal, and enough riveting on the roundabout to be sure that it could be
4431 calked against. I do not care to further segregate the 5 cents per pound, as I am better satisfied with the 5 cent pipe than I would be with some of the details. I know how much a farm wagon costs me, but I do not know how much of it is paint, how much of it is wood, iron or labor, and it is not essential that I should know. I have never been in charge of a pipe factory, and have never built pipe, although I have inspected the building of it.

Questioned by Mr. Searls.

I think it would cost a little more to fabricate a steel pipe than it would wrought iron pipe, as it does not calk as easily nor punch as well. I think the manufacture of the wrought iron pipe would be a little cheaper than the steel.

Dockweiler Witness: J. H. Dockweiler, for Defendant.

4432 DIRECT EXAMINATION BY MR. SEARLS.

In ascertaining the unit costs of this appraisal, I assumed that the water company had an organization to carry out the work of designing, superintending, and administering the construction, and that included a purchasing agent, and that the company would buy materials and have them in suitable store yards to be given out as required; that the actual fabrication of the material would be done by contract. The principal sources from which I have checked my judgment of the various unit costs are observation and quotations, and on some of the work, experience. I also have records of contracts let prior to this on other jobs, and have had more or less access to the records of the Spring Valley Water Co., and to a certain extent checked from those records.

I testified in the 1903-4 case between the Spring Valley Water Co. and the City, and in connection with that case I examined the minutes of the company up to the year 1908.

Riveted pipe: I first ascertained the character and fitness of the metal comprising a certain pipe line, and from that I computed

the weight of the metal in the fabricated pipe without any coating. I work it out by the straight plate itself; I computed how much iron 4433
would be required in the plate, the weight of the rivets, and made an allowance for the overlap. For instance, for a 36 inch pipe I determined just how much plate would be required to make the barrel, how many rivets were required, and how much loss there would be in overlap; in other words, I divided a finished length of pipe into the necessary material to fabricate that, and that gave me the weight of the metal, which comprises both the plate and the rivets per unit of length of that size, and for that gage or thickness. Take the 36 inch pipe, gage No. 3, that is a quarter of an inch thick. The weight per foot is 111 pounds. In arriving at my price for that I proceeded as follows:—I will take the 36 inch, No. 7.—that is 3-16ths thick, and weighs 83 pounds to the foot. The cost of the metal, which includes the rivets, I took at 4 cents a pound. The actual shop cost of labor on that is 0.50 cents per pound, and the overhead on shop labor is 50%, which makes 0.25 cents per pound. The total up to this point on the plate, labor and overhead, on the labor is 4¾ cents per pound. I took 50% profit on the overhead and labor; in other words, 50% of 0.75, and called that 0.38. That gave me 5.13 cents up to this point. This is a pipe that is laid in the city, and so I allow 6.15 cents per 4434
100 pounds for a haul an average of 4 miles, which brought me to a figure of 5.1915 cents per pound, or delivered at the side of the trench that pipe would cost 5.19 cents per pound. I calculate my profit only on the labor, and have assumed the price of the material laid down in San Francisco. I assume that the profit in fabricating would only be on the labor, as the material man, or whoever sold it, has already made his profit.

San Andres line: I have a 44 inch No. 7 iron that is 3-16ths 4435
thick. The 3-16ths weighs 100 pounds to the foot. Plates cost 4 cents a pound. Fabrication for that size is 0.50, and overhead is 0.25, which makes 4.75. A profit of 0.38 brings that to 5.13. Freight, haul and distribution 0.11. That brings that to 5.24 per pound for the pipe on the trench, and does not include the cost of dipping, which has to be added extra. Dipping is 44 cents per lineal foot, weight 100 pounds. That is $5.24 a foot undipped at the trench. The cost per foot dipped is 44 cents, so that the pipe on the side of the trench, dipped, is $5.68 per foot. The cost of laying is 49.1 cents per foot, bringing the total cost of the pipe laid up to $6.17 per lineal foot, to which is to be added the cost of excavation and trenching. The cost for the latter varies as to the location and the nature of the material.

Mr. Hazen: The 44 inch No. 7 in my table, where I have a decimal 4436
is 0.187. I had it 101 pounds per foot. The 113 pounds is with steel.

Mr. Dockweiler: The remaining 21 cents between the figure of $6.38 and the figure I have given you of $6.17 is probably due to

particular conditions surrounding that type as to the nature of the joint, or something similar to that. In my original work I have opposite each a key check showing where the computation for that particular item is to be found. I have no general computation which covers everything. Each item is figured out by itself. Referring to my excavation and backfilling; the excavation is 51 cents a yard, and the backfilling 20 cents, which makes 71 cents per yard for that particular pipe.

Questioned by Mr. McCutchen.

I have not the number of yards to the foot here. We just computed that. That gives a total of 39,766 cubic yards; the length of the pipe totaled 28,895 lineal feet, so it is a little over a yard to the foot.

Questioned by Mr. Searls.

That also includes the excavation for the 44 quarter inch pipe, and the unit price for 26,851 lineal feet I have worked out at $7.95 for pipe without any excavation or backfill. Roughly speaking, it is 1 1-3 yards to the foot, which would be about 95 cents a lineal foot for the excavation and backfill.

4437 Questioned by Mr. Metcalf.

I have the weight per foot of each size pipe. The 44 inch No. 7, weighs 100 pounds to the foot; the 44 inch, one quarter weighs 140 pounds to the foot. The 37 inch, one quarter weighs 114.14 pounds to the foot. The lengths are given here as follows: 2,044 feet of 44 inch No. 7; 26,851 feet of 44 inch ¼; 1,414 feet of 37 inch ¼. The total amount for the excavation and backfill is $28,313.38.

Questioned by Mr. Searls.

My total sum for the 27 items of structure No. 11, San Andres
4438 Pipe line, is $267,934.90, which is exclusive of overhead.

Questioned by Master.

Mr. Hazen and I checked up on weights, I think, within 1% on an average, and had the same price of 4 cents for the metal.

Mr. Metcalf: The difference of $101,000 on the structures is purely on the fabrication.

Mr. Dockweiler: I have for excavation and backfilling 71 cents.

Mr. Hazen: I had 75 cents.

Mr. Dockweiler: We agree within 4 cents a yard there.

Mr. Metcalf: The chief difference is in fabrication 3¾ cents as against 1½.

4440 Mr. Searls: As far as weights are concerned, I don't know why there should be any disagreement.

Mr. McCutchen: There is a very radical difference between Mr. Dillman and the others. For instance, pipe that Mr. Dillman assumed will weigh 60 pounds to the foot, Mr. Hazen says will weigh 72; Mr. Dockweiler says will weigh 70, and Mr. Lawrence's figures are 67.7. Mr. Hazen testified he actually gaged the iron himself, and Mr. Law-

rence's weights are the actual weights of the pipe that went into the trench.

Mr. Hazen: I gaged the pipe. I took Mr. Lawrence's data, and I revised the weights that I omitted by the formula, practically discarding it, and making a new calculation just as nearly in accordance with the facts as I could get at them, but the weights I am talking about are the actual weights based on gaging and on Mr. Lawrence's weights.

Mr. Searls: I understood until I came into court yesterday, that the weight proposition was covered by the agreement of the engineers as to quantities; I find now that it was not.

Mr. McCutchen: There is a very radical difference in other items. On the 44 inch, No. 7 line Mr. Hazen's weight is 101; Mr. Lawrence's 4441
100.2; Mr. Dockweiler's 100; and Mr. Dillman's 97. On the 36 inch, ¼ Mr. Hazen's figures are 110; Mr. Lawrence's 109.3; Mr. Dockweiler's 111; and Mr. Dillman 97.

Mr. Searls: I do not desire to make any admissions in Mr. Dillman's absence, but I will consent that he may confer with your engineers, if you wish, and see if there can be any agreement on that question.

Mr. Dockweiler: In ascertaining my weight, after figuring the theoretical weight of the plate, I added 3% to carry overhead; I assumed that a plate of a certain size would run 3% for overhead. I do not know what happens to it, but that is what you have to do, and that is what the best men who are still in this shopwork, and who buy the plates inform me, and I followed their advice.

Mr. Hazen: My understanding is that Mr. Dockweiler allowed 4442
3% for loss in weight of manufacture, which was the same percentage that I allowed, and I think that is what he means when he speaks of 3% overhead. Then I allowed 1% for the miscellaneous metal work along the line not included in the weight of the straight pipe, and he did not add that, but estimates the bands separately, so that taking that into account, my figures being not more than 1% different, I think there is absolute accord. Mr. Lawrence's figures do not make those allowances, and are somewhat lower. He weighed samples of the fabricated pipe; these weights represent only a few pieces, and are therefore inadequate to determine the weights of the whole lines. He made them many years ago for another purpose, and took them for what they are worth, and it is very interesting information.

DIRECT EXAMINATION BY MR. SEARLS.

Referring to the question of fabrication; I have corresponded with pipe men around the bay and in Los Angeles. I wrote to the Lacy Bros. Manufacturing Co., under date of February 20, 1914, as follows: "I am enclosing you a list of pipes on which I desire you 4443
"to give an estimate. The figures I desire assume the fabrication of

"the pipe in the region of San Francisco Bay, with the delivery f.o.b. "San Francisco, during a period of two years previous to January 1, "1914; that is to say that you were manufacturing the pipe during "the years 1912 and 1913. You can readily see that a job of this "size would demand in the interests of economy and efficiency fabri- "cation of the pipe in the vicinity of the bay region". This was the Lacy Bros. of Los Angeles, and they returned to me the list filled out, giving weights per foot, and this weight is for the pipe dipped, as he says in a subsequent communication, and these prices are for steel, to which he said there should be added 20% for Allan Wood iron. The prices are as follows:

Price per 100 pounds. 12 inch diameter, No. 12 gage	$3.90
You add 20% to that for Allan Wood iron.	
12 inch No. 14 gage	4.00
13 inch No. 14 gage	4.00
4444 16 inch No. 12 gage	3.90
18 inch No. 12 gage	3.90
22 inch No. 7 gage	3.60
22 inch No. 9 gage	3.65
22 inch No. 10 gage	3.75
22 inch No. 11 gage	3.80
22 inch 3-16ths inch thick	3.60
22 inch ¼ inch thick	3.25
23 inch No. 7 gage	3.60
23 inch ¼ inch	3.25
23 inch 5-16ths inch gage	3.20
23 inch ⅜ inch thickness	3.20
24 inch 3-16th inch gage	3.60
30 inch No. 3 gage	3.25

These are f.o.b. San Francisco, and this is a list of the Spring Valley pipes, and none other.

30 inch No. 11	$3.80
30 inch No. 12	3.90
30 inch 3-16 inch	3.60
30 inch ¼ inch thickness	3.25
30 inch 5-16th inch	3.20
33 inch No. 3	3.25
36 inch No. 7	3.60
36 inch No. 9	3.65
4445 36 inch 3-16ths	3.60
37 inch No. 3	3.25
37 inch ¼ inch	3.25
44 inch No. 6	3.50
44 inch No. 7	3.60

44 inch ¼ inch	3.25
44 inch 3-16th inch	3.60
54 inch 17-64 inch	3.25
Riveted steel pipe, 50 inch, 5-16 inch thick	3.20
54 inch 5-16 inch thick	3.20

The prices f.o.b. San Francisco assume fabrication of pipe at any point within 60 miles of San Francisco, all pipes to be double riveted, and double dipped; all wrought iron pipe to be of grade equal to best Allan Wood iron. That weight includes coating. The weight according to this table of 22 inch, No. 9 is 40 pounds per foot. For 22 inch, ¼ inch thick it is 72 pounds to the foot. The lighter this pipe is, the heavier it turns out at the same unit price per pound, the more profit he will make. 4446

30 inch ¼ inch,	weighs	88	pounds
44 inch ¼	"	132	"
36 inch No. 7	"	80	"
36 inch 3/16	"	80	" 4447
37 inch No. 3	"	110	"
54 inch 5/16	"	200	"

That includes his dip. The following letter was read:

"Lacy Manufacturing Company

"I beg to acknowledge yours of March 5th, in which you enclose "your estimate of costs steel pipe as per lists submitted you by myself. "Regarding your answer, I wish to trouble you again: First, does the "weight which you give per lineal foot include dip? Second, what "do you estimate the weight of your dip per square foot of service. surface "Three, does the statement 'these figures are all made for steel pipe, "and—for Allan Wood iron—you should add 20% to the estimate "on sheet, means to add 20% cost to the weight of the plate, or to the "price per 100 pounds of fabricated pipe'. For instance, 5/16ths, "107 pounds weight per lineal foot, price per 100 pounds $3.20 will "make the cost of Allan Wood iron 64 cents additional, or $3.84 per "100 pounds of fabricated pipe."

He replies on March 5th as follows: "Referring to yours of the 4448 "9th inst., regarding estimated weight of pipe, beg to advise you that "the weights as given you were for the pipes complete, including dip. "The weight of the dip adds approximately ⅜ths of a pound per "square foot. Regarding the extra cost for Allan Wood iron over "steel, will say that 20% additional for the iron should be added to "the price for 100 weight of fabricated pipe; that is for 30 inch, 5-16 "gage, weight 107 pounds per foot, the cost for steel would be $3.20, "and for iron $3.84 per 100 weight of fabricated pipe. This, we trust "will guide you in your estimates."

I know that the Lacy Bros. did furnish some pipe on the Aqueduct, and they have furnished considerable for the Los Angeles Water Department.

4449 The Western Pipe & Steel Co. under date "27th February, 1914".

"Replying to yours of the 21st inst., we beg to quote you prices on "wrought iron pipe and riveted steel pipe as per list herewith. Prices "are all f.o.b. cars Richmond, Cal., and for double riveted and double "dipped pipe, made according to our standard practice. Our standard "practice may be covered roughly by the following specifications:

"Longitudinal seams, double riveted, efficiency of joint from 65 to 75%.

"Circular seams single riveted.

"All pipe No. 10 gage and heavier will be double sheared and calked.

"Pipe made up in approximately 20′ sections.

"Pipe No. 14, No. 12 and No. 11 gage slip joint.

"Pipe No. 10 gage and heavier punched for field riveting.

"All pipe to be double dipped in pure California asphalt.

"prices are all based on cost of iron at the mill:

"$2.45 per C lbs. for 3/16 and heavier.
2.50 " " " " gages No. 9 and No. 10.
2.55 " " " " gages No. 11 and No. 12.
2.60 " " " " gage No. 14.

"We are giving you these prices so that if you want to make any ad- "justments of our figures on basis of the different mill cost of iron you "can do so.

" Trusting the above will give you all the information desired, "and assuring you that if we can give you any further information, we "will be glad to do so, we are,

"Yours very truly,
"Western Pipe & Steel Co. of Cal.
"C. H. Ramsden,
"Engineer."

4450 This letter was in response to mine of date February 24, 1904.
4451 In addition to these quotations I ascertained the cost from the Los Angeles Water Department of bids and actual contract prices for pipes fabricated and delivered and dipped on the side of the trench for the Los Angeles Water Department. I used these quotations merely as a guide in forming my estimate, because I know that when a man really wants the job, he will bid lower, because these men are actually engaged in work, and we know that these figures there are outside figures; when they really come to figure on the work, they would beat that price. Everything that I have received inclines me to the sense of security in my figures that the work can be done for the prices that I estimated. There was no doubt about it at all after consulting the

work as to the prices and bids for the Los Angeles work. The pipe there is just as good a class of pipe as made up here. 4452

Under date of February 10th, 1914, the Lacy Manufacturing Co. had awarded to it contracts for approximately 5,920 feet of ¼ inch riveted sheet-steel pipe, 52 inches in diameter. This pipe was contracted for at the rate of $4.09 per lineal foot, and all bends were half a cent per pound extra. This pipe, as I have computed it, weighs 143 pounds to the foot dipped, and that is at the rate of $2.85 per pound, complete, on the side of the trench in Franklin Canyon, and a very crooked and hard road to get up. It is a 12 mile haul from the Lacy shop. 2.86 cents

I assumed a steel plate in San Francisco $2.50 a hundred, 2½ cents a pound, and I took a differential of 1½ cents a pound between steel and wrought iron; that is rivets and metal and everything. If you want to find my price for steel, where I have taken 4 cents, deduct 1½ cents. My position is 2½ cents for steel, where it is 4 cents a pound for wrought iron in San Francisco. I mean steel plate and rivets. I have not made any difference in the cost of fabricating the steel and the wrought iron. The steel is a little harder, and harder to punch, but I do not know as that works out so much; in shop prices you have these big punching machines, and I have seen them punch what they call an iron plate in the same time they punched the steel. I think if it is by hand work that possibly the steel is harder to handle, but with these great big machines an iron plate is punched as quickly as steel plate. Steel plate is wider and usually longer than the wrought iron. If you are making a 52 inch pipe, one plate is just as large as the other; they are rolled for the same size. 4453

Mr. Hazen: No, Mr. Dockweiler, because with the wrought iron the widest plate you can get is 60 inches; in the wrought iron that is as wide as they can roll, and they very much prefer to roll narrow ones, while in the steel plates you would ordinarily use 84 and 90 inch plates.

Mr. Dockweiler: Then you would have more round seams in a given length in the wrought iron than you would in steel.

Mr. Hazen: Exactly.

Mr. Dockweiler: I am taking the length of the seams as I found them in the pipe. A man taking steel pipe makes his seams wider so as to get a less number of seams. 4454

Mr. Hazen: If you were building a steel pipe you would not build it in 60 inch sheets, that would be foolish, because you could get the wider sheets just as readily.

Mr. Dockweiler: Bids for the Los Angeles Water Department, opened November 11, 1913, for 2,650 feet of 30 inch steel pipe. This is 5-16 steel, and I estimated the weight of this pipe at 109 pounds a foot. The successful bidders were the Llewellyn Brothers where the bid was $3.44 per lineal foot of pipe; the other bidders were $3.48,

$3.51, $3.61, and $3.93 per foot. Dividing the $3.44 by the 109 pounds per lineal foot, that figures that pipe at $3.15 per pound. I took the plate and made a rough computation; it may be a little bit more, because I did not make any computation for the rivets, so if I got
4455 any more weight, my weight would come down per pound. I made the rough computation of 109.35 pounds. My price per lineal foot included the pipe dipped and finished, and the contract is to make delivery of certain pipe along the route above indicated. The pipe is to extend along Western Avenue, from a point 24 feet north of the south line of Third Street to a point 71 feet south of the Wilshire Boulevard, a distance of approximately 2,650 feet. That was in the City of Los Angeles. Those Los Angeles prices, fabricating within 60 miles of San Francisco, would be about the same. There isn't much difference in them. The only difference would be to bring it to a true basis figure, the difference between steel and iron. There isn't much difference between the wage scale in Los Angeles and here; the wage schedule of the manufacturers of this type do not cut much of
4456 a figure in it. You would not have to add the freight, because with a large job like this they would build a ship up around here if they got the job. I purposely fixed it 60 miles outside of San Francisco, because the Western Pipe & Steel Co. does not work under labor union conditions in Richmond. My impression is that the number of hours to a day in Los Angeles are about 9 hours, and maybe 8, I am not sure, but the figures they gave me here are bids that show what they do when they want a job, and it shows me the range of the bids.

4457 I have some prices which I got from Mr. Riffle, who is either the contractor, or the brother of the contractor for the Bull Run Pipe Line, as to the cost of doing actual trenching on the Bull Run Pipe Line, in Portland. The data I have here is data prepared by Mr. Riffle, the manager of the steel pipe department of Dunham, Carrigan & Hayden, and these are details of successful bids, and not the final cost of the work. He was the contractor, and these were the prices that were paid.

4458 Here is another job in Los Angeles. This was prepared at my request by Mr. Mulholland's office, under date of June 25, 1914; cost of 40 inch riveted steel pipe, 32,428 feet in length, laid from Sunset Boulevard to Third and Western, comprising 4,509 feet of ¼ inch. This gives the sum total of those costs, and was done by Mr. Mul-
4459 holland's crew, and by Mr. Mulholland's direction. They said that they just finished the job the day that was gotten out. The item of $505 supervision on $190,000 worth of work, may have been his general foreman on the work. Mr. Mulholland has a very efficient organization, and that may have been the charge of one of his office men on it. This is accompanied by this note: "Dear Mr. Dockweiler: Enclosed "find data on completed 40 inch pipe line. We are just finishing this "up today, and data has been dug out under orders from Mr. Mulhol-

"land at high speed. Have not had opportunity to figure out unit "costs, so I am sending it as it is, in order to make the mails. With "kindest regards".

Mr. McCutchen: I would not take it for granted that this came from Mr. Mulholland.

The cost of the pipe at trench sides was	$146,730.00
Gates f.o.b. Los Angeles, that is valves	3,049.12
Fittings	556.57
Miscellaneous materials and supplies	1,011.21
Trenching, including coal, oil, etc., for trench digger and labor	15,009.70
Pipe laying, including derrick crew, riveting and blacksmith labor	14,359.40
Backfilling, watering, rolling, etc.	7,374.90
Trucking	1,078.00
Incidental labor	300.00
Miscellaneous equipment	192.37
Watchman	316.05
Supervision	505.00
Total	$190,582.32

4461

That figures out $5.87 per lineal foot. I have also the cost of laying the 30 inch 5/16 riveted steel pipe on Western Avenue from Wilshire to Third Street, which I obtained from the Los Angeles Water Department. Mr. Mulholland sent me this personally, and it was laid between February 4th and March 12th, 1914.

4462

Length of line, 2,629 feet at 3.45 a lineal foot, pipe	$ 9,064.87
Fittings, connections for consumers, supplies and regulators, .23 a lineal foot	609.36
Gates, including regulator gates, .63 a lineal foot	1,663.95
Miscellaneous material and supplies, .03 cents per foot	91.48
Trenching, laborers, .39 cents a lineal foot	1,026.40
Trenching machine, coal and oil	106.54
Labor	155.65
Repairs, .11 a lineal foot	20.00
Derrick crew, labor .05 a lineal foot	124.25
Riveting labor $738.65; riveting, coal and coke $9.50 at .28 a lineal foot	748.15
Miscellaneous labor, .14 a lineal foot	368.75
Blacksmith labor, field and shop .03 a lineal foot	77.45

Trench refilling, includes steam roller, team and labor, also 1500 feet haul of surplus dirt, .34 a lineal foot	892.95
Trucking, miscellaneous, .02 a lineal foot	42.00
Repaving 424 square feet, .04 per lineal foot	106.00
Rolling street .01 per lineal foot	26.40
Oiling street .02 a lineal foot	52.78
Night watchman, .03 a lineal foot	74.00
Total	$15,250.98

Total unit cost per foot $5.80. The above costs on excavation and laying were somewhat increased by reason of obstruction in the shape of water mains, gas pipes and storm sewers. Accompanying this Mr. Mulholland wrote me, under date of April 13, 1914: "You will notice the unusual and expensive accessories on this short line".

SIXTY-FOURTH HEARING. NOVEMBER 19, 1915.

Witnesses: J. H. Dockweiler for Defendant.
Geo. L. Dillman for Defendant.
Allen Hazen for Plaintiff.

4463 (Certain corrections noted in the transcript).

Mr. Hazen: For the No. 9 gage in the Alameda Pipe Line I have used the thickness 0.163, and I notice that the other engineers use a
4464 lighter thickness that ordinarily corresponds to No. 9 gage. These plates were not the commercial No. 9 gage; the specifications state that they shall be not less than 6.4 nor more than 6.6 pounds per square foot for No. 9, and the diagram accompanying the specifications shows the figures 0.163, the figure which I used, and which corresponds exactly to the 6.5 pounds per square foot. I have calipered the plates of this pipe at various times, and they have always run at or above this thickness. Using the nominal weight makes a difference of about 4½%, or about 4 cents a pound, over $15,000. The original order of pipe of this gage was 3,645 tons of plates, and the total amount in the system estimated 4,313 tons, so I think in the interest of accuracy that everyone should correct their schedule to the actual thickness. The weight of the pipe per lineal foot is the figure that I used. I was higher than everyone else on that item, and that is the reason why I was higher. That does not involve a change in any of the tables that I have introduced. I applied this to all the No. 9 in the system,
4466 and used 0.163 all the way through. I have not certain information as to other lots of No. 9, but this is on the basis of 85% of the whole system, and I took it for all. I do not think I gaged any other pipe
4467 except the Alameda pipe. It is my impression that all the other No. 9 items in the schedule followed the Alameda, and I think there

would be a presumption in my mind that the Spring Valley used the 9 for the others; I would not take that as conclusive evidence against any other evidence, but that is what I did use in my work. As to 85% of the whole system, it is approximately clear, because 85% of it was bought under these particular specifications that we have, and as to the remaining 15% approximately, there may be some doubt. 4468

Mr. Dockweiler: In the 36 inch, No. 9 I have the long sheet 117, and the short sheet 116. The width of the sheet 44 inches. My gage is marked No. 9, and I took the weight at 70 pounds a foot.

Mr. Hazen: I check with you as to the 36 inch, No. 9, but I took the weight at 72 pounds, and if you add 2 pounds to the foot, you will be correct according to this memoranda.

DIRECT EXAMINATION BY MR. SEARLS.

Referring to the table just examined, one sheet marked 108 in the upper righthand corner shows my estimated cost of riveted 4469
wrought iron pipe delivered at trench, undipped, in cost per pound. The sheet marked 109 in the upper righthand corner gives the cost of riveted wrought iron pipe, delivered at trench, undipped, in the city, giving the cost per pound. Sheet 110, marked in the upper righthand corner, gives the cost of riveted wrought iron pipe per foot, riveted joints, in country.

These three sheets marked "Defendant's Exhibits 100, 100a, 100b". Sheets showing quotations of the Western Pipe & Steel Co., giving in detail the weight per lineal foot, were introduced and marked "Defendant's Exhibit 100c".

That is a copy of the original letter received by me from the Western Pipe & Steel Co., quoting me prices on riveted wrought iron pipe, in accordance with the specifications to which I testified yesterday. (A correction was inserted over the column headed "Weight 4470
per lineal foot" by putting in the words "weight does not include dip").

I have received in response to an inquiry under date of November 5th, 1913, from the Schaw Batcher Co. Pipe Works of San Francisco, a letter which contains further figures in support of my estimate on riveted pipe. Introduced and marked "Defendant's Exhibit 100d".

In the minutes of the Spring Valley Water Co., under date of February 15, 1900, Book F., page 89, I have found evidence of prices received on advertisements for bids, and showing ranges of bids on making 44 inch, 37 inch, and 36 inch pipe, and specials. There were three bidders, the Risdon Iron & Locomotive Works, the Union Iron 4471
Works, and Schaw, Ingraham & Batcher. Bids show that the Risdon Iron & Locomotive Works, for the fabrication of 44 inch pipe, bid $3.425 a foot; Union Iron Works $4.35 a foot; Schaw, Ingraham & Batcher $1.65 a foot. Translating this into per pound, the Risdon

Iron & Locomotive Works' bid was 0.283 per pound; the Union Iron Works' bid was .036 per pound; the Schaw, Ingraham & Batcher bid was .0136 per pound. There may have been some purchases since then of riveted wrought iron pipe; I do not know.

Mr. Hazen: I think there was quite an important order in 1902 or 1903, and very little since that time. I have a recollection of these prices that Mr. Dockweiler has just put in, but they were not included in my schedule, for the reason that they did not cover the whole of the work, which was covered by the other prices which I filed. I think that the company asked for bids in their usual form, and that the Risdon Iron Works' and the Union Iron Works' bid on the work which is comparable to the work in the table which I made, and that this Schaw-Batcher bid came with a letter, saying that they would do
4472 a part of the work for this price, and they were permitted to do that part of the work for that price, but it does not include the whole work comparable to the other manufacturing cost.

This abstract from the minutes was introduced and marked "Defendant's Exhibit 100e".

4473 The copy of the Lacy Manufacturing Co. bids will be marked "Defendant's Exhibit 100f".

Mr. Dockweiler: I have a tabulation of bids for the work of the City of Sacramento Water Supply, which was received about April 20, 1915. These are proposals, and canvas of proposals for the furnishing and installing of riveted steel and cast-iron water pipe, valves, hydrants, and other appurtenances in the City of Sacramento. This is a tabulation made by Mr. Whitney, a civil and hydraulic engineer for the City of San Diego, of all the bids received in the City of Sacramento. These bids were for freight on pipe, fittings, valves, and hydrants included. These bids were in writing, being covered by specification No. 67. The specifications according to which the bids were made are entitled as follows: City of Sacramento, California, Department of Engineering, Office of City Engineer, contract documents, extension of water distribution system, contract No. 67, for
4474 the furnishing and installing of riveted steel and cast-iron water pipe, valves, hydrants, and other appurtenances in the streets, alleys, and rights of way of the City of Sacramento, 1915. 20 inch pipe 3/16 inch, Schaw Batcher Co., $2.25 a lineal foot. F. Rolandi $2.41 a lineal foot, Bates, Borland & Ayer $2.30. Hans Pederson $2.48 a lineal foot. James Kennedy $2.36 a lineal foot. Southerlin Construction Co. $2.42 a lineal foot. Graff Construction Co. $2.55 a lineal foot. The Turner Co. $2.56 a lineal foot. Clark & Henry Construction Co. $2.30 a lineal foot. Eaton & Smith $2.91 a lineal foot. Mathews Construction Co. $2.50 a lineal foot. P. E. McHugh $2.42 a lineal foot.

For 24 inch pipe; 3/16 inch thickness: Schaw Batcher Co. $2.75 a lineal foot. F. Rolandi $2.87 a lineal foot. Bates, Borland & Ayer $2.87 a lineal foot. Hans Pederson $2.85. James Kennedy $2.85. Southerlin Construction Co. $2.83. Graff Construction Co. $3.10. The

Turner Co. $3.12. Clark & Henry Construction Co. $2.70. Eaton & Smith $3.58. Mathews Construction Co. $2.46. P. E. McHugh $2.92.

30 inch riveted steel pipe, ¼ inch metal; Schaw Batcher Co. $3.85 a foot. F. Rolandi $4.20. Bates, Borland & Ayer $4.23. Hans Pederson $4.45. James Kennedy $4.30. Southerlin Construction Co.

30 inch riveted steel pipe, ¼ inch metal: Schaw Bacher Co. $4.16. Graff Construction Co. $4.75. The Turner Co. $4.60. Clark & Henry Construction Co. $4.16. Eaton & Smith $5.35. Mathews Construction Co. $2.46. P. E. McHugh $4.32.

¼ inch plate, 36 inch pipe: Schaw Batcher Co. $4.25 a lineal foot. F. Rolandi $5.19. Bates, Borland & Ayer $5.05. Hans Pederson $5.49. James Kennedy $4.80. Southerlin Construction Co. $4.82. Graff Construction Co. $6.01. The Turner Co. $5.57. Clark & Henry Construction Co. $4.85. Eaton & Smith $6.35. Mathews Construc- 4475
tion Co. $5.749. P. E. McHugh $5.11 a lineal foot.

That is for pipe delivered in Sacramento, and includes the fabricating and laying. It is set forth in detail in contract No. 67. I do not know who was the successful bidder. The tabulation will show 4476
who was the lowest bidder.

Mr. McCutchen: Minute Book F of the Spring Valley Water Works does not show any special letter accompanying the Schaw Batcher bid, but it does show this: "It was thereupon moved that the "bid of Messrs. Schaw, Ingraham, Batcher & Co. for making pipe re- "quired as contained in their letter of March 13, 1900, be accepted". I do not think these minutes of themselves throw very much light on the subject. 4477

Mr. Dockweiler: I understand the Sacramento work is going on now, but I have not had time to investigate it. I have not gone through the specifications sufficiently to know them in detail. The specifications state the size of the plate and the diameter of the pipe, and it gives you an idea of what men will fabricate and put it in the ground for. The specifications call for the making of the pipe under inspec- 4478
tion, and I understand there is an inspection for the rolling. I am using this as a confirmatory figure, and it is confirmatory of the fact that I am perfectly safe in the figures that I have submitted.

It can be stated that when you actually come to calling for the performance of the work upon which you have received bids, conditions being the same, that the bids will be lower than the quotations you have received.

Witness: Geo. L. Dillman for Defendant. Dillman

DIRECT EXAMINATION BY MR. SEARLS. 4481

In 1898 or 1899 I had charge of the construction of riveted pipe by the Risdon Iron Works for the Contra Costa Water Co. That work

was bid in, the contract let, and the work finished at the contract price; with responsible bidders, the contract is generally finished for
4482 the contract price. The preliminary prices given engineers on request for the purpose of preliminary estimate, are almost invariably cut when the contractors are bidding to get the work. I can cite you a recent case of that, in the matter of meters for Haywards. The Haywards Water Co. was recently ordered to install meters. The ordinary price for meters of the size installed there was about $13; the usual quotations for the purpose of estimating, are $8.60. Each meter company is ready to declare, through its salesmen, that that price will absolutely not be cut. In this case the company is a closed corporation. They proposed to pay cash for these meters, and install 750 now, and the order was for 1,000. The highest bid was $7.20, then there were a lot of allowances, such as furnishing a man to install them, until we finally bought those meters, and they are good meters today, at $5.95. That is only a sample of what is done continually with supplies of various kinds, and you can do it with lumber. I have some knowledge, and can therefore state it to be a fact, that a great deal of the lumber for the construction of the Panama Pacific was not only
4483 furnished, but drayed to the site for $11 a thousand. The prices have always been cut to the man who had the cash to buy, and is not to my knowledge true to a greater extent now than it has been during the past three or four years.

I know that wrought iron pipe is not a class of material which would be exempt from the rule. Pipe companies are just as anxious for business, and as ready to cut each others' throats, as any other competitors. The big steel companies do not allow an independent inspection of steel that is manufactured at their plant; an independent inspector for the purchaser is allowed to go there and see the in-
4484 spection made, but an independent inspection is not made in these mills. They take contracts under all kinds of specifications, and vagaries of specificators, and roll out the same stuff to fill every one of them. The American Bridge Co., which builds most of the railroad bridges in the country, the various railroad companies have tried to have make special steel, and they have threatened to ask a withdrawal of their contracts, and the manager of the steel trust said, "All right, gentlemen, we are turning out commercial steel, and we cannot change our methods of manufacture to suit you". The only time when an independent inspection was made in my experience was when the armor plate was inspected at Harrisonburg, and the inspectors, Sampson, Alger, and Ackerman, insisted upon making an independent inspection, and it raised such a row, it went to the United States Sen-

ate, and was in the papers for months. This thing of specially-made material is a good deal of bunk. I do not know whether that is true of wrought iron. This inspection of the armor plate resulted in the charge that the mills had been delivering plates that were way under specifications, but I do not know whether that was so or not. I hope it made a difference in the manufacture of armor plate, but do not 4485
know that it did. I do not know what the practice was at the time these Spring Valley pipes were made as regards inspection, and I have not read the specifications under which the pipes were made.

Various contractors purchased the lumber for the exposition, and the purchase of the lumber was not all under the supervision of Mr. 4486
John A Hooper. I do not know whether the purchase of the lumber was under the direction and supervision of Mr. Hooper, and I do not know whether Mr. Hooper appealed to the lumber concerns here to put their prices down in order to encourage the building of the exposition buildings. 4487

Witness: Mr. Allen Hazen, for Plaintiff. Hazen

CROSS EXAMINATION BY MR. SEARLS.

I did not assume that the Spring Valley Water Co. would pick up a cheap man to superintend the construction of their system. I meant a good average management with respect to the management of large enterprises, as they are carried out in the country; that involved getting good men.

Questioned by Master.

I assumed that the Spring Valley Water Co. would reproduce the plant as represented in my estimate. I assumed that the plant was 4488
to be reproduced by a new organization, but an organization made for that purpose, and as efficient as is ordinarily reached in enterprises of that kind.

CROSS EXAMINATION BY MR. SEARLS.

Ordinarily a private concern will get an efficient organization, but the efficiency of organization cannot be specified in advance. With equally good intentions, and comparatively equal facilities, sometimes a better organization will be built up than others, and the results that are reached by the best organizations in the country are not to be taken; it is, rather, the results that are obtained by all of them, and then reaching a fair result with reference to all the data. Mistakes will be made in any large work. I did not assume that the man in charge would be guilty of gross extravagance which would greatly

enhance the cost of the system, or of unusual idiosyncrasies in design, without giving corresponding efficiency. I acquired my familiarity with labor conditions on the Pacific Coast by observation and inquiry. I have never had any actual experience out here in making pipe or other waterworks materials. I have not designed or estimated any such costs for Pacific Coast plants. I have made some estimates, but I thought you were inquiring as to actual construction. I made esti-
4489 mates for the City of San Francisco, and for the Peoples Water Co. The latter estimate was for the re-financing in the Railroad Commission, and the former was an estimate based on the Sacramento Water Supply Project.

The principal difference between Mr. Dockweiler and myself on pipe lays in the cost of fabrication. I included the hauling in the cost of manufacture, and the hauling of these pipes is rather expensive, and I know generally that it is not done at the same rate per ton mile as other material. You cannot transport big fabricated steel pipe at the same price per ton mile that you can carry cast-iron pipe; that is a fundamental fact, and does not depend upon labor conditions. The
4490 absolute cost would depend on cost of teams, and the men that drove them, or whatever you use for transporting them, but the fact that that cost was more for this particular kind of material than for other kinds I think is general; it does not depend on the local cost of labor or teams.

Questioned by Master.

My haul is included in the 3.75 cents; 4 cents is for the material.

CROSS EXAMINATION BY MR. SEARLS.

I estimated that hauling on a basis of $5 a ton, and the actual cost to the Spring Valley for the work done by it, as far as I could get the records, came out about $3.90 per ton; in another estimate, which I think does not appear among the papers that I presented for work done at the present time, I used $5 as a fair price. Most of the Spring Valley records relate to a time when wages and teams were paid less money than is paid to them at the present time, so that the labor cost would increase that from $3.90 per ton. I formed a judgment at $5 before I had the Spring Valley costs.

My total cost per pound, on an average, of the pipe in the trench,
4491 was 3.75. $5 a ton would be .25 cents per pound, but that is on the whole weight of the pipe, and as the coating is nearly 10%, and we are speaking of the cost per pound of the metal, only 10% would have to be added to that, which would make it approximately 0.275 for hauling, based on weight of metal. I took the bends and man-holes

on the basis of the actual cost of the items that I could get from the Spring Valley experience as 0.304.

Mr. Metcalf: I do not think that Mr. Hazen and Mr. Dockweiler are far apart on the question of man-holes, bends and extras—I have not made any analysis yet.

Mr. Hazen: The average for those items of 63% of the Spring Valley system was 2.89, and I think my figure was just a little under 4492
theirs; 2.75 checks pretty well.

I cannot give you the details of my shop cost of fabricating; I base it on a schedule of costs which has been in use in our office for the purpose of estimates, and which is made up on the best data that we could get to account for the finished cost of the works that we had to do with and knew about, and was prepared without any reference to this case. It was used in making different figures in the American Civil Engineers' Pocketbook, which is published, and which also has been used for general estimating, and which I believe to be a reliable basis. I do not mean by that that the work always costs the same in every case, but a representative average figure. As a check on that figure, I took the contract prices of pipe, delivered f. o. b., and delivered in the trench, according as the contract read, in two classes; ¼ and 5/16ths inch plates.: I deducted the average price of steel for the year in which the contract was made at Pittsburg, and the approximate freight rate, because in some cases I did not know the exact freight rate, and I used the approximate weights, and subtracted those two items, which left a figure for comparison with the schedule. I recognize that is a very rough check, and I only present it as a check. The figures that add up in that way check almost exactly opposite the schedule. There is a good deal of variation. The work represented in these different contracts was sometimes better, 4493
sometimes worse; the engineering inspection was sometimes better, sometimes worse. I could not tell you about that as to the different items, but in a general way that evidence to my mind confirmed the general reliability of our office schedule. To that I have added 20%, because in my judgment the cost of manufacturing at San Francisco would be 20% greater than in the places where the pipe was made, on an average that was represented in these figures. I have not had any experience with pipe work in San Francisco, but it is not a fact that we use mostly foreign labor of the cheapest sort in those eastern pipe works. I have never made pipe anywhere, but I am familiar with pipe works, because I have had pipe made, and my inspectors have always been in the shop where it was being fabricated, and I have visited them very frequently. These are not records of complete costs;

they are records of contract prices, and in every case but one the contracts were performed as to the unit price. These are contracts, not for the complete work, but simply for the delivery of the pipe, and,
4494 of course, the amount may be greater or less than the contract, and there might be extra work in connection with it. I have no record of that, and these costs are incomplete as to that. The costs that I have are defective to that extent. The cities in which these pipes were purchased are all entered on the sheet that I submitted yesterday, on page 3 and 4 of my tables.

Referring to Portland, Oregon; I have seen some of the pipe, and I am familiar with the shop of the East Jersey Pipe Co., in Patterson, N. J., where it was manufactured. That price was delivered at Portland, and in that case the difference representing the cost of manufacture, dipping and calking, was 1.34. That does not include the part of the manufacture represented by putting the pipe together in the trench. That is simply for the pipe delivered f. o. b. Portland. I do not think for that particular item that I found out what the
4495 cost of the riveting and calking in the trench was. The cost which I have used for riveting and calking in the trench; for ¼ inch plate the office schedule is ½ cent a pound, and making that addition, the total cost of that particular pipe would be 1.84.

Ottawa: There was 3,000 feet, or a little over a half mile of pipe on that job, which was fabricated at the East Jersey Pipe Works, and that price is delivered at Ottawa, and includes duty at the Canadian frontier, I think. The 7½ cents a pound represents the cost f. o. b. Ottawa, and all of these prices are on the full weight of the pipe, including the coating, and not the metal only, and in that respect are not comparable with the Spring Valley price, which is modified to meet the local practice. The Spring Valley prices should have added to them for comparison, not the cost of coating, but the differ-
4496 ence in the base weight of the metal taken; that is, the finished pipe weighs 10% more approximately than the metal, and in all our work ordinarily, all the calculations are based on the complete weight of the finished pipe; in this case, by our figures, we base it upon the metal only, and that means that the price per pound, and the cost of manufacturing is 10% greater than when it is figured on the metal only.

I do not think the Ottawa cost is very closely comparable with the Spring Valley price in any event, but so far as that item is concerned, 10% should be added to it to make it comparable with the figures that are used in this case. I can tell you the history of the Ottawa case; Ottawa was suffering from typhoid fever, and the condition was very bad. They wanted to get a pipe to make a certain connection, and wanted to get it just as quickly as they could. I

bought that pipe. I went to Gillespie, of the East Jersey Pipe Co., the only place that I knew of that could get out that quantity of pipe quickly. He was making another lot of pipe, and had to stop the other manufacture, put the other people aside, and get these plates in from Pittsburg, and make up this lot of pipe, and get special trains and run them right through to Ottawa. He did it in a very few days; I would not tell you how many, but it was an emergency order, and he said, as he had shut down his mill and put it through, he thought he ought to get that price for it, and it certainly isn't fair to take it into 4497
account alone, and I did not consider that the Spring Valley pipes were going to be produced on a rush order.

Questioned by Master.

I might have left this Ottawa result out, and it would have been the same, but if that were to have been left out, another item would be left out, when the contractor failed and could not execute his contract, and another would be left out, because it is not possible, for this reason, strictly, the whole business isn't proper evidence, it simply shows what the conditions have been in this case, and looking at it broadly, it does aid, I think, and is a proper aid in forming the judgment as to the cost of manufacture.

CROSS EXAMINATION BY MR. SEARLS.

Winnipeg: The length of pipe purchased there was 42,500 feet, 4498
furnished by the East Jersey Pipe Co., and also subject to the Canadian duties. The duty was not a matter of much importance at Ottawa, as American manufacturers in sending pipe into Canada have to meet foreign competition, which is sharp, and the duty on steel pipe is very low. The American pipe has been sold in Canada at pretty nearly the same rate as on the American side. I do not know what the cost of riveting and calking was in that case. That pipe was made according to special specifications. There is no such thing as standard pipe in the sense that there is in cast-iron pipe. Of course, I could not tell you as to whether the standard was very high, or just the average in this particular case. Colonel Rattan was the engineer, and he is a good engineer; I did not see the specifications of the pipe. 4499
The East Jersey Pipe Works, which I think have made more pipe than any other concern in the United States, are capable of making a very excellent pipe, and they also have made some very bad pipe; there has been a great deal of difficulty with some pipe they have made under inadequate plans and specifications. They are like other contractors. They will make what people buy and pay for, and I do not recognize any general standard that is applicable to all work. There are different standards according to the requirements of the different purchasers. I could not answer with certainty whether this price includes bends and man-holes. At Ottawa the price included everything of that sort.

The general estimate of October 30, 1912, is the schedule that has been used in our office as a general schedule for this estimating. It has been revised from time to time as we have got added data, and the one of October 30, 1912, is the one that is still in use.

4500 The costs from Los Angeles were furnished me, I think, by Mr. Mulholland. The second item, ¼ inch plate, is 19.10; Dove Spring Canyon, 1,032 feet of 108 inch by ¼ inch plate, and that price includes the putting the pipes together in the field. I could not tell you where Dove Spring is. It might be that it would include quite a high freight differential from Los Angeles to Mojave, and also considerable haul from Mojave out to the canyon. In this particular list, I have only the particulars of different pieces of work, the length and dimensions, price per foot, price per pound, and the class, referring to just what it covers in respect to completeness of work; that is to say, "a" represents the price f. o. b. cars; "b" represents the pipe put together in the trench; "c" represents the price put together in trench including excavation and backfill; "d" represents the cost of completed line. I have not the supporting particulars of that before me at this moment.

Portland job: Miscellaneous auxiliary structures does not refer to the bends and man-holes. It refers to all the things that had to be furnished and done after the shell of the pipe, including all bends and man-holes, are complete. I class the bends and man-holes as part of the pipe always, and the reason I have done it is probably the reason why I have segregated some of this data in that way. It seemed to me that the bends and man-holes were part of the pipe. The man-

4501 hole is furnished for convenience in building the pipe, and not for any use afterwards. The valves and blow-offs, on the other hand, depend on topography, and the contractor builds them because the engineer requires him to, so I treat these as auxiliaries, and also gates along the line, and anchorages, and all the other things that are necessary to complete work. Such data as the above, in itself, is no guide. I do not remember where the Los Angeles pipe was made. I think the most of it was made in Pittsburg, and was shipped without the side riveting being done, and then set up in the field, but all the work of making it into pipe had been done in Pittsburg. It was punched and bent all ready for riveting.

The 1911 job in Los Angeles, at 3.79, was 1,000 feet of 120 inch by

4502 ¼ inch pipe in the main aqueduct. I do not remember where it was made. This was part of all the steel syphons on the aqueduct, and was selected as being the only one where ¼ inch plates were separated so that a separate figure for ¼ inch could be obtained. All the other syphons were in whole or in part thicker plates, and where the plates were of special thickness, Mr. Mulholland had not separated the cost according to sizes. These Los Angeles jobs which I have enumerated here, subject to what I have just stated, are all of those which Mr.

Mulholland reported to me. I took out all the items of ¼ inch work, and of 5/16ths inch work that could be separated, and they are all in this table that I have presented. Where thicker plates came into the line, and they were not separated, I have not taken them into account, because I thought there would be no profit in carrying the comparison to thicker plates than 5/16ths.

Akron, Ohio job, 1912: I only advised in regard to that. There 4503
was 28,600 feet of ¼ inch pipe laid in the neighborhood of the city; it was part of the city waterworks, and was a pipe of the diameter of 36 inches. That was the price for the pipe in the trench, with the riveting and calking done, but not including the excavation. It came from the Carroll, Porter Tank & Pipe Co., of Pittsburg. I 4504
think that included bends and man-holes, and so on. A reduction should not be made for that in the way I used it, because I compared the figures that I reached in this way with the Spring Valley figures, which included the straight pipe, the man-holes, bends, dipping, and transportation, all added up. This price of 3.75 cents per pound includes the bends and man-holes, but that, of course, is on the actual metal, while the prices in this table are on the completed pipe. The 3.75 includes the calking and riveting, excluding the trenching, and then I make an addition for my auxiliary. The bends and man-holes are not auxiliaries in my classification. They are kept sharply separate, and are in the 3.75. This price of 4.71 at Akron, Ohio, did 4505
not include any of the auxiliaries that I have mentioned as being added to my Spring Valley price. In that respect they are strictly comparable with all the items included.

Referring to two Los Angeles items. The first one is of 611 feet of pipe 132 inches in diameter, ¼ inch thick, and the second, 1,572 feet of pipe of the same size, and I think from the size it was part of the main aqueduct, but I could not say where. I assume that price includes the bends, the lengths being short and the size large, I presume there were no man-holes, but I do not know whether that is a fact or not.

I made no estimate of the number of yards on the Portland 4506
job at all. I have figured the cost per foot for excavation, and compared that with the estimate as I made it in this case. The depth that was covered on the Portland lines is the depth on the Spring Valley lines, and it is very similar country. I can give you the details of the yardage; for 54 inch pipe, trench 86 inches wide and 90 inches deep, 2 cubic yards per lineal foot. For 44 inch pipe, 72 inches wide, 80 inches deep, 1.48 cubic yards per lineal foot. For 37½ inch pipe, 63 inches wide, 73 inches deep, 1.18 cubic yards per lineal foot. For 36 inch pipe, 62 inches wide, 72 inches deep, 1.15 cubic yards per lineal foot. For 30 inch pipe, 54 inches wide, 66 inches deep, 0.92 cubic yards per lineal foot. For 22 inch pipe, 40 inches wide, 58 inches deep, 0.60 cubic yards per lineal foot. Multiplying those yards

per lineal foot by the length of the principal lines in excavation—
4507 this was not carried to all of the 68, but to the principal lines—gave me 479,211 cubic yards, and the agreed quantities of excavation for the same items are rock 10,455, earth 472,020, total 482,475; in other words, the agreed schedule was about 3,000 yards, or a fraction of 1% more than the figure which I used. So far as this table is concerned, there is no excavation concerned in any way.

I have given the cost per lineal foot of the Portland excavation, and the character of the country through which that pipe line ran was originally heavily timbered. When they ran the pipe line through, they had to do a good deal of grubbing out of roots, and very heavy work in excavating their trenches. The City cleared the
4508 tract and built a road on it as a preliminary, and the cost of doing that was not included in the price of the line, as first reported to me. I afterwards got it, and included, it makes quite a substantial addition, but the cost of the pipe line as reported, and as shown by the figures representing, is the work after the way was cleared, and after a road had been built, and there was no more grubbing than there would be in ordinary work in laying the line afterwards. The pipe line was laid in the road that was built for that purpose as a preliminary. I inquired as to whether there was very heavy grubbing in putting the pipe in there. I was not there.

Mr. Dillman: The pipe line route was through heavy timber. I bid in and took the contract for doing the clearing of that road; it did not include much grubbing. The roots that were partly on the surface of the ground were taken out, but the roots that were left there, through which the trench had to be dug, were oftentimes as big as a man's body, and it was a large part of the cost of that
4509 excavation to do that grubbing. It is heavy fir timber.

Mr. Hazen: The cost of excavation on the first line, laid in 1894, was comparatively low. The cost of the excavation in 1911 was very much greater. That was laid through the same tract that had been cleared perhaps 18 years before. The figures that I quoted related to the second line, and not to the first one. If the contractor who built the first line was able to get out whole at those figures, he did pretty well. I do not know whether he did or not.

Mr. Dillman: Something like 80% of that line was timber I should estimate.

Mr. Hazen: The Portland item in the schedule is for the pipe f.o.b. Portland, and does not include laying in the trench, and I think that is not any part of the Bull Run Line; there was 1500 feet of 48 inch pipe, and that is all in this classification. That is the Portland, Oregon line in 1909, 5/16 inch pipe. I think that pipe was part of the city water system, and I think it is lower than the ¼
4510 inch. I think that was riveted ready for laying. I think Mr. Clark

gave me that information, but I am not certain as to just where I did get it.

Boston job, 1911: It was 80 inch, 5/16 pipe, and was a part of one of the aqueducts of the Metropolitan Water Board. That is the price complete fabricated, but does not include the work in the trench. The small lengths of 500 or 600 feet are not so good an indication for computing the cost of thousands of feet, such as in the Spring Valley system.

Minneapolis lines: The first one was for 11,770 feet, of 54 inch pipe, costing 7.20 per foot, and the second was for 23,000 feet of 48 inch, 5/16 pipe, at 6.78 per foot f.o.b. Minneapolis. That included the pipe riveted and calked, so far as the shop joints were concerned, but not riveted in the trench. That pipe was made by the East 4511
Jersey Co., and I saw parts of it. Our office base corresponding to these figures is 1.70, and I based a comparison on it; I did not use it directly. I used an average price for all plates of the Spring Valley system, but coupled with the statement that a fair analysis would show that it was more for the thinner, and less for the thicker pipe, but I did not attempt to separate it in the statement which I filed the other day. It is rather difficult to compare the figures that I have for the thicker pipes here with my average base. We have an approximate idea of the additional cost of handling thinner pipe, that we used in our estimating of the difference, and that is shown by these figures which follow the general estimate under the different items. Our general estimate of October 30, 1912, does not include an addition for Pacific Coast conditions. That is for the 4512
eastern conditions. In the case of the 5/16 inch, my own contracts do not check my general estimate exactly on that part of the schedule. Under the 5/16th, including riveting and calking, this Akron pipe is the same one to which I refer above; its length is 3900 feet, the cost $6.20 per foot, being 36 inch pipe.

Victoria, B. C., 1914: That price must have been before the commencement of the European War. The pipe was fabricated in Canada. The contract was first let to a local contractor, who was unable to carry it out, but he delivered the plates on the ground, and the contract was afterwards re-let to a second contractor, who took the plates and fabricated them on the ground and laid the line. I think these were Scotch plate, but I am not quite sure. Unless you 4513
were going to compare this with the Scotch iron in the Spring Valley, the conditions are scarcely comparable with those here.

Questioned by Master.

If I were revising our office schedule of October 30, 1912, I would not revise it on the 15 contracts that are shown in page 3 of the memorandum. I gave the fact that these particular contracts over-ran, sufficient weight to add 6 cents a pound in my costs on page 15 of my schedule; perhaps it would have been better if I had not

included that .06 in the calculation. If I did not include .06, it would approximately reduce my figure to 3.69. In other words, I should have more confidence in my office base than in this particular
4514 information.

CROSS EXAMINATION BY MR. SEARLS.

The increase of 20%, if the work was considered as done in San Francisco, is my judgment. I cannot prove it by any statistics, but in my judgment the labor conditions in San Francisco are such that it would add to the cost of the work, and the cost of manufacturing would be greater because all the freights on the machinery, and all the incidentals would have to be bought, and because there would be delays in getting prompt deliveries of material from the steel mills, and delays cost money. I have had—of course this is not legal evidence—friends and acquaintances who have done metal work in manufacturing lines in San Francisco, and who have done it elsewhere. They told me about the relative costs. I did not consult anyone in San Francisco, and have not had any pipe built here myself, and have not contracted for any here, nor designed any. I have given some estimates for contemplated construction to the Spring Valley Water Co., but that had nothing to do with this case.
4515 One of them was the proposed pipe line from the Calaveras Reservoir around the head of the bay. I am not aware that local engineers had also figured on the same line. Mr. Elliott, the engineer of the company, has made some figures on it, but I am not aware of anyone outside of Mr. Eastman, Mr. Elliott and I, who were fully informed as to what these figures are. These figures have not been adopted, and no contracts have been let on the basis of them.

4516 I had no estimates from anyone that it would cost 20% more to make pipes in San Francisco. That represents my judgment, based on knowledge of labor conditions, and what I have learned by talking with a good many people who had to do with these matters in different parts of the country. I do not know in detail the wages which are paid in the local pipe factories, or in the eastern factories. I talked with Mr. Mulholland about the cost of getting pipe on the aqueduct, and also the Los Angeles City Water System. Los Angeles work has been done very cheaply. I think I can say that the cost of fabrication in Los Angeles is higher than it is in the East, but I could not say just how much; it may not be any
4517 higher. It is possible that if the Los Angeles prices were the same as those in the East, and the freight from Los Angeles to San Francisco were 27½ cents, that it might be cheaper to have the pipes shipped from Los Angeles, and fabricated and sent up here.

I do not know any of the details of the labor costs in Portland, and I did not inquire at any of the local pipe factories in Portland as to what it cost them to make pipe. I think I did have some

figures for Seattle pipe, not comparable with this, however. The Seattle pipe price was for pipe laid, which includes the trenching. 4518
The cost of manufacturing pipe is made of the cost of labor, the skill of the manufacturer, the equipment, and to some extent, the patent rights that are controlled. There are a great many things that come into it besides the cost of labor, and to say that the cost of labor is 10% more than it is here, therefore the cost of making pipe is 10% more, does not follow. There are no patents involved on the pipe, but no doubt there are patents on the machinery to be used in fabricating it. There are patents controlled by the East Jersey Pipe Co. that have had a profound effect upon the pipe business as a whole, and I think there are no pipe foundries in the country which can make pipe as cheaply as they can. I give no consideration to quotations. One can get them from any manufacturer, and they mean nothing whatever. The East Jersey Pipe Co. sell pipe 4519
cheaper than other people do, but I do not know that it follows that if they control patents that the patents do not affect the cost of producing pipe. They have sold it cheaper to get the business.

I think that the patent rights which the East Jersey Pipe Co. 4520
may have has tended to lessen the cost of pipe as compared with the prices that other foundries charge, and I think the appearance on the market of a new method, and a firm of capacity looking for business, tended to lower the price; it does not follow that they will get all the business there is, and because they don't get all the business, it does not follow that the price and general market is not affected. I believe the prices have been cheaper because of the operations of the East Jersey Pipe Co., but they have not monopolized the business by any means. I did not assume that the Pacific Coast foundries would be unable to manufacture pipe at a price that would compete with the eastern prices. I think that the Pacific Coast foundries would not be able to get as good labor as the eastern pipe foundries, because it is not here. I know men would be brought out, 4521
but not enough to completely man the shop. If they had a contract to build thousands of tons of wrought iron pipe at 4 cents per pound per plate, they would import men as far as they could, but the whole quantity is not a very large order in the world of pipe manufacture.

Mr. Searls: An engineer of the Western Pipe & Steel Co. told me last night that if he had a chance for a job like that, it would not take him long to get up an organization that could handle it on exactly the specifications that the pipes were built on.

Mr. Hazen: They built two of the Spring Valley pipes, and as compared with the others in workmanship, they were very inferior; 4522
they were under-riveted, not calked, and not properly trimmed. That is one of the lines of pipe that I criticized the other day, and it is my judgment that the work they put on the job which we looked at is not more than from one-third to one-half of the work that would

be put into manufacturing the same pipe under such specifications as Mr. Schussler would have given, or that I should have given.

CROSS EXAMINATION BY MR. SEARLS.

There is comparatively a small amount of that kind of pipe in the Spring Valley system; a little over 400 tons in the Pleasanton line, and a mile or so of 30 inch pipe in the Merced line. They are both conduit pipes, and for those particular lines they were sufficient. There were no specifications for that construction at the time.

4523 I do not want to insinuate that the Western Pipe Foundry is unable to manufacture the same quality of pipe as the eastern foundries, because I have no doubt that they can make as good pipe as is reasonably necessary, if they had a proper plan and specification, and were held to it. The most important thing is that it is only partly made, and it answers the purpose where it is laid, but in comparison with the pipe line, it does not compare with other pipe; it does not give any idea of the cost of properly manufacturing a pipe line. The fact that these people made it does not show their capacity for manufacturing pipe.

I understand that the pipe line recently laid through the park was fabricated by a San Francisco firm, but I have not seen any part

4524 of it. Mr. Elliott said he thought it was not standard riveted, but he did not criticize it for that, because the pressure is not very high.

Mr. Metcalf: It is my impression it was some under-riveted. The coating did not compare with the Spring Valley coating. This was in the nature of a rush order, and I believe that the Spring Valley did not dip it.

Mr. Dockweiler: The contract price for the pipe was 87½ cents a foot for straight pipe, and it weighs 100 pounds, so that is 87½ cents per 100 pounds, or .087 cents, which covers the cost of manufacturing it, the dipping of it, the contractor supplying the rivets, the riveting up of the pipe, and the trenching.

4525

CROSS EXAMINATION BY MR. SEARLS.

I have examined pipe built by the Risdon Iron Works, and as far as I remember, every piece of the pipe was good, and that would be an exception to the general rule that I make with regard to the Pacific Coast pipe factories.

All of the calculations and estimates ordinarily made in our office are based on the nominal weight of pipe, which is obtained by multiplying the thickness by the diameter, and the product by

4526 12½ and adding 10 pounds; that being a rule which is very closely the actual weight of finished steel pipe, and we use that rule uniformly in making all these calculations, and straightening our records out for use.

Questioned by Master.

That is the nominal weight, and is a very close approximation to the actual weight of ordinary steel pipe. When I started with this Spring Valley pipe, I followed that method, and then I was faced with the situation that this pipe does not weigh the nominal weight, and I did not want to come in here and talk about pipe that weighs 100 pounds when really it does not, so I found out what the actual weight was as nearly as I could, and took for that purpose the weight of the metal, because that is the system that has been followed locally here. I made that confession to the local practice, and the difference in the Spring Valley pipe is 9.4 percent, so when anything is brought out of the water company's records, and put on this basis, this 9.4 percent has to be added to make it comparable. This principally is dipped; there is a little variation, because the wrought iron is lighter than steel about 2%. My formula covered both at the same time. The cost which I have given from my schedule of 1912, and the cost on which all these contracts of which I have spoken were based, were taken on the basis of metal, plus the coating weight, whereas to apply this to the Spring Valley pipe, you must add 9.4 percent, because we are figuring the Spring Valley pipe on the metal without 4527
the 9.4 percent of coating.

Mr. Dockweiler: I think Mr. Hazen and I practically are in accord on the uncoated weight. I think the Spring Valley coating is the best coating made in the United States.

Mr. Hazen: It is not my understanding that my formula is universally followed in all the eastern cities, but I think it is a perfectly fair thing to use it in reference to these contracts, because it represents the weights of all ordinary steel pipe lines where the pipes are bought to gage very close. That is a formula that I have used for a long time, and I think it is as near right as you can get it. It does not apply to the Spring Valley pipe, and I do not believe it would apply accurately to any thin wrought iron riveted pipes, and it certainly does not apply to plates that are bought by weight. 4528
In a great deal of the pipe on the Coast, both in San Francisco and Los Angeles, the plates are bought to weight, and it makes more difference with the steel than it does with wrought iron whether they are bought to weight or gage, because the steel plates are wider and vary in thickness. I expect that steel plates bought to weight are 8 to 10 percent lighter, and cheaper than plates bought and made to gage, so that is a very important matter, and is one reason why some of these prices that we have got from California run so low.

The Spring Valley plates were bought by weight as far as I know, with the exception of the plates bought from the Central Iron & Steel Co., in Harrisburg, which were bought to gage, and the pipes made from these plates are relatively heavier for the same dimen-

sions than all of the rest of the Spring Valley pipes. I could not tell you whether the Los Angeles, Portland and Seattle pipe lines conform to this practice, but some of the pipe of the Los Angeles aqueduct, the heavier plates, were bought to gage. With that exception, the ordinary practice of the Los Angeles Aqueduct is to buy by weight. At Portland the pipes were all bought to gage; I am not
4529 sure as to Seatle.

Questioned by Mr. Dillman.

With a 48 inch, ¼ inch pipe, if you buy it by the foot, you get 8 or 10 percent less pipe than where the pipes are sold to gage. Where they are bought to weight they are thinner than where they are bought to gage. The Spring Valley bought almost all of its
4530 material by the foot, and not per ton. It was then manufactured and laid by the pound, and not by the ton. There is no difference buying by the pound and by the ton, but Mr. Dillman spoke yesterday of a long ton. A long ton isn't known, as far as I know, in the riveted pipe business.

Mr. Metcalf: In the quotation of tank plates, I think sometimes it is, but not ordinarily with us in the east. Certainly not in steel pipe work. There is usually a higher grade of metal put into fire box steel than what we call ordinary metal steel tank plates. Bearing upon this question of the weight and thickness, it must be borne in mind
4531 that the edge of the sheet as rolled is generally thinner than the middle of the sheet. That bears upon the question of buying to gage or to weight. I suppose a manufacturer would gamble on the care of the inspection, and if he felt that the inspection was to be careful, so that measurements would be taken, and the purchaser realized the difference, it would make no difference in price. There is also something in the flow of the metal as the sheet comes into the roll and comes out again.

Mr. Hazen: The gage is taken at the edge of the plates by the calipers, and if you compute by gage, you get the advantage of the natural thickness of the middle of the plate. The bulge of the metal is the same whether you buy to gage or weight. The difference is if you buy to weight, you get a plate that averages ¼ inch through the whole section, while if you buy to gage, it is ¼ inch thick at the edge, and averages perhaps 10% more than the edge of it in the whole section. The difference is the same in both cases. The Spring
4532 Valley bought to weight, except for the two lines that they bought from the Central Iron & Steel Co., and they were bought to gage. The excess weight in those cases was 8%. I do not criticize the practice of buying to weight. It is all right if you want to do that way, only you are not getting so much metal, and it is not comparable without that fact being taken into account. When they buy to weight, it averages ¼ of an inch throughout the whole section of the plate; it is more than ¼ of an inch in the middle, and less than

¼ inch on the edge. When they buy to gage it is ¼ inch or more on the edge, and averages considerably more than ¼ inch on the whole section. To reproduce the existing pipe line, instead of getting 4533
¼ of an inch gage, you might get a fraction above 3/16ths; that is the common practice in California at the present time, and it has been followed in some of the Spring Valley lines.

I found it was the practice here to base the calculations on the metal, and I deferred to that practice, and figured the weight of the metal pipes. The practice has a good deal to recommend it. In doing that I took a similar basis. The pipe has weighed 100 pounds, made up of metal and dip, and we will say, just to illustrate, and without attaching any significance to the figure, that I wrote that at 9 cents a pound. That is $9. Now, if you say that the metal in that pipe weighs 90 pounds, and we are going to take that as the weight of the pipe, and call it 90 pounds, then I add 10% to my price and get $9; it doesn't make any difference whether I take 4534
9 cents a pound on 90 pounds, or 9 cents a pound on 100 pounds. That relates to fabricating, and I have discussed fabricating on the basis of finished pipe. To make it comparable with the other figures, I am putting it on the metal only, and it is bound to be 9.4% greater than when reckoned on the weight of the pipe. Most of the data as to the cost of fabrication is contained in some volumes of records 4535
which I obtained from Mr. Sharon. I also went over these things with Mr. Lawrence last year, and I got all that he could give me at that time. I think these contract prices were all taken from this series of books that I refer to, and the size of the pipe, the year, 4536
and the length in feet, are taken from these records. Then the contract price for straight pipe is taken from these books. The estimated weight is the estimate that I made up from the data that I had. The total weight in pounds was obtained by multiplying that by the length of the schedule here. The total amount of work was obtained by multiplying the contract price by the length in feet in the schedule. The cost in cents per pound is obtained by dividing the next to the last column by the last column. On page 33 this covers the Crystal Springs line. It includes the Crystal Springs, the San Andres, and the 54 inch Alameda, and a few secondary lines, and is all the data of that kind that I was able to find. The three contract prices that were mentioned this morning, I found that they are limited, so are not comparable with these prices, and could not properly be brought into this schedule.

I have heard 87 cents quoted as the contract price of the Schaw 4537
Batcher Co. for laying this pipe in the park.

Questioned by Master.

The item 2.873 cents per pound includes the work in the shop, 4538
and the work in the trench; it does not include transportation, dipping, or the metal. It is for straight pipe only. The 2.87 is obtained

by dividing the total amount of work by the total work, and not by averaging the figures above it. To average the figures would not give quite the same result, because some of the items are larger than others; dividing the total, is I think a fairer way of averaging than the other way.

CROSS EXAMINATION BY MR. SEARLS.

In getting at my figure of 3.75 for fabrication, I personally gave the most weight to my office practice. The three ways used were
4539 the three ways of approaching the subject that occurred to my mind as being the most certain and conclusive in reaching a fair representative result. I tested it in the different ways, and as it turned out, they all gave very closely the same result. The fact that the estimate at the present time is equal to the apparent cost of manufacture, I regard simply as a coincidence. On the other hand, it is a very reasonable proposition, because the price of labor has increased, and the methods of making pipe have improved. It seems very reasonable that the cost 25 or 30 years ago should turn out to be the same as the cost now. I did not bring the contract prices down to present conditions. I am putting here, as nearly as I can, just what it costs the Spring Valley to make the pipe, without any corrections of any kind, and considering that for what it is worth in considering the whole subject. I considered both of the other methods helpful, particularly if you apply to the contract price some factor which would
4540 make eastern practice comparable with Pacific Coast conditions.

Wrought iron as a material for making large pipes is practically out of the running, but it is still an important material for making small pipes. Somewhere from 10 to 15 percent of the small welded pipe in the United States at the present time is made from puddled iron, and I should think 3 or 4 inches would cover most of the small pipe; some of it would run larger. There are a great many 3 or 4 inch pipes in the country system of the Spring Valley Water Co., but they are not in the schedule we are discussing now. There are a great many people in the United States who are willing to pay a great deal more for pipes to get the extra durability of wrought iron, and perhaps there is more reason for doing that in the small sizes than there is in the larger ones. I mean by that, the advantage of durability may be as a percent greater in comparison with the extra cost of the metal in the small pipes than in the large ones.

4541 I have done a great deal of studying on the question of wrought iron pipe in the last ten years, and I prepared specifications, and in one case we got alternate bids on wrought iron as compared with steel. I have never laid any wrought iron pipe, and I doubt if large wrought iron pipe is going to be laid. I think that wrought iron is a wonderful structural material for pipes. It was replaced with steel in the enthusiasm of the arrival of a new material on the market; a

material that was cheaper and stronger, and could be obtained in larger plates. I think the shift went perhaps too fast and too far, but it has gone, and I do not believe it will go back. The steel pipe of the last decade or two is not going to be the pipe of the future I 4542
am sure. We are going to have better pipe. I would like to use wrought iron in any pipe line, if I could, but you cannot get it in big sheets, and we are in the habit of making very large pipe out of two sheets in 30 foot lengths. That is one sheet for every 15 feet on an average, and is common practice. Pipe built of wrought iron plates that could be got would look as though it was made up with postage stamps in comparison. That is a very important matter. That is one of the disadvantages of wrought iron, and is a disadvantage that counts a great deal more as the size of your pipe gets larger. If you were making small pipes, the advantage of wrought iron pipe would be greater, especially with thin plates, but when you get to the big and heavy pipe, you cannot get wrought iron pipes 4543
to make them in the way we make them; we have to use steel.

There has been a great deal of difference in the practice of dipping the steel pipe, and a great many different methods have been followed. I am somewhat familiar with the New Bedford line in Massachusetts. They thought they used a very excellent coating. I do not remember the reference in the "Engineering News" you refer to. I know the superintendent of the New Bedford Works very well, and he has told me about the condition of the pipe from time to time, and it was satisfactory for quite a long while. 4544

Mr. Metcalf: I was one of those who made the inspection of that line the last time, and I read the article published in the "Engineering News", which was based on a report made by their superintendent, Mr. Coggeshall, and that in turn was based upon memoranda which Mr. Merriman and I gave him. The pipe laid in 1896, was 48 inch, 5/16ths steel plate pipe, riveted. In 1913 we found a 10 to 20 percent increase in the number of tubercles, but there was no increase in the depth of the pitting, so far as the gagings that we were able to make indicated. We took a comparatively large number of readings with a micrometer of the depth of the pittings, and that average was substantially the same as the average which Mr. Merriman had gotten at the inspection 5 years or so before. The tubercles had increased, and it may be that the blistering also increased. We 4545
had expected to find that there had been a progressive increase in the depth of the pitting, and the amount of the tubercles, and it was not as rapid as we thought we would find it. So far as it had significance, I think that was considered a very encouraging circumstance by steel pipe manufacturers all over the country. The indication was that perhaps the tubercles would not go on as rapidly as we feared it might. The quality of the dipping may have been a factor, but of course we do not know just what the occasion was for it.

Mr. Hazen: The New Bedford Line, the Albany Line, and the Washington Line, which I dipped myself, were dipped with asphalt. There was a run for asphalt as there was for steel. People thought that asphalt was better than coal tar which was used before that, and that it made a better coating, the physical properties being better,
4546 and that the asphalt lasted for ten years on the pipe, and coated the pipe almost perfectly. When the asphalt gets more than 10 years or so old, it gets oxidized by the oxygen in the water, and it all gets brittle and loses its life. On the Albany Line, which was built in 1897, the coating has all lost its life, and it is almost now as if it was not coated at all, and that is generally true of the asphalt coated pipes of that period. What saved the Spring Valley was that they mixed coal tar with the asphalt. It was a stroke of genius in getting that mixture. I don't think they knew when they got it what it would do, but they certainly made a hit. The Rochester Line, laid in the early 70's, was wrought iron; the second Rochester line, laid in the early 90's was steel, and was coated by Kuichling; that has given a great deal of trouble by pitting. In Portland, on the Bull Run Line, there is a mile or so of pipe that requires a good deal of
4547 repairing, because the pits have gone through.

Undoubtedly if everybody used as good a coating on steel pipe as Mr. Schussler used, the pipe would have stood better; that is not the sole, or the principal difference in the behavior between wrought iron and steel pipe. The steel pipe perforates. Mr. Kuichling, who studied this matter very hard, studied the perforations on the Rochester Line when they first began to come 15 years ago, perhaps, and he told me that as far as he could get at it, everyone of these perforations came from an original surface defect in the plate of the steel. On the lines I built afterward, we insisted on very rigorous inspection of the surface of the plates for just those defects. We have had the plates turned at the mill so that the inspector could see both sides. That added some expense, as we find that if we inspect the plate critically for surface defects on both sides, that a good many of the plates are rejected, and when we reject a good many plates, the mill says they have to have more per ton.

SIXTY-FIFTH HEARING. NOVEMBER 22, 1915.

Witnesses: ALLEN HAZEN for Plaintiff.
LEONARD METCALF for Plaintiff.
J. H. DOCKWEILER for Defendant.

CROSS EXAMINATION BY MR. SEARLS.

(Certain corrections noted in the record.) 4548

Referring to page 4519 of the transcript, wherein I stated that the East Jersey Pipe Co. has had an exceedingly large business, and had got it in competition, which means that they sell that pipe cheaper than the other people do; they must have sold it cheaper in particular cases than other companies did, otherwise, they would not have gotten 4549 the business. I did not mean that it was because of the exceedingly large business they did, that they sold it cheaper, but that they must have sold it cheaper, because they were in competition, and had an exceedingly large business.

The only data that I could get as to pipe lines—Los Angeles costs—are those I have given as to Dove Spring Canyon, Jawbone South, Quigley, and Placerita. In some of the other lines the pipe was a composite one, and these were the only items relating to ¼ inch pipe. In the other lines they were ¼ inch plate, and also thicker plates in the same line, and the costs were not separated. They were unable to separate them for us in Los Angeles, so it was not possible to use them. I do not know that I ever had a record of the pipe in 4550 the Antelope line. The Antelope syphon is reported to be ¼ inch to ⅜ths, and that means there were three sizes, ¼, 5/16 and ⅜. The total cost of 3.3 cents is about right on their figures, Mr. Metcalf says. I have 3.35 without the engineering. I should take the cost of the Antelope line into account for what it is worth. There would be quite a substantial difference where you run from ¼ to ⅜ inches. I 4551 think, I gave on the ⅜ths .9 of a cent less per pound than for 3/16ths. 3.75 is my estimate of the cost of fabricating, dipping, transporting, and laying the pipe in the Spring Valley system. That is not comparable to what we are talking about now. No doubt the cost of fabrication in that case was less than I have estimated for the Spring Valley system.

Mr. Dockweiler: Antelope Valley Syphon: The steel and rivets at the mill cost 1.476 cents a pound; the railroad freight cost .8 cents per pound; the loading and hauling cost .32; the erection is .11, and that means placing it without any riveting; the riveting was .26, the calking was .05, the painting, which would be equivalent to our dip, is .04; the syphon equipment—that is what I consider as the tools and the plant used—was .2; the engineering is .04; total with engineering 3.3 cents per pound in place, without excavation or backfill. Call it 3.26, and you exclude the overhead, but you have your tools in here; 4552

that is for metal and everything. That is for the steel and the rivets at the mill per 100 weight, and for the metal rolled and punched.

Mr. Hazen: My cost includes rolling and punching. I do not know what kind of metal they bought, nor what it cost. That is one of the uncertain features of this comparison. I do not know whether it could be less than 1 cent. If you deduct the cost of the metal as 1.475, rolled and punched, and engineering at .04, and get the fabrication cost, exclusive of those two items, as being 1.79, and add to that the cost of rolling and punching the steel, I think undoubtedly it will not bring it to 3.75.

4553 Mr. Metcalf: I have the Pine Canyon line cost at 3.48, excluding any allowance for engineering or overhead. Your memorandum, which includes .1 of a cent, would make it 3.56 as against my 3.48, including the metal. The metal in this case is given at the same rate, 1.476.

Mr. Searls: Adding to that the .1 of a cent, and subtracting 1.57 from the total cost of 3.66, it gives 2.09 cents as the cost of fabrication, except the bending and riveting.

Mr. Metcalf: That is all on the ¼ inch, or larger; out of 3,205,000 pounds, approximately 298,000 only was ¼ inch. I have only the length and the weights of the ¾ inch pipe, I have not the costs. They were unable to apportion the cost on a percentage basis, but in cost it is less than 10% of the whole.

Mr. Hazen: I have a total of 7,000,000 pounds in the Antelope line.

Mr. Metcalf: I have 7,220,000, and they report 6,649,000, but their weight records are not altogether consistent; we found that out

4554 in comparison with Mr. Hazen's formula. About 1/3 of it is ¼ inch, being 2,788,000 out of 7,000,000 pounds. I did not accept their weights as final. I found the actual weight was about 92% of the total weight, the indication being that if that was all the metal they accounted for, it would increase the cost per pound as reported by them, because they probably had not gotten all the weight that there was in the pipe line.

Mr. Hazen: The Los Angeles costs for ¼ inch pipe were con-

4555 siderably less than the cost I have given, and if I added the 27½ cents per 100 pounds freight to it, it would still not bring it up to 3.75.

Questioned by Master.

I think that comparison is not an indication at all of what the work would cost here. The work is not comparable at all. This was taken at a time when work was scarce and prices were low. I think most of the items that are in here were taken by people in the steel business who were new at this kind of work, and it often happens that people bid too low in work of this kind. I think these people did bid too low, and were pinched; they lost money on it. Further, the specifications for the steel were not exact; it was possible to fully meet them by delivering a grade of steel that would not have been

accepted on any of the eastern works with which I have had to do; how much difference that made with the price nobody knows. The pipe was not coated at all. It was painted, and according to the figures which have just been read, the cost of that painting was about .1 of the cost that I agreed on with Mr. Dockweiler as to the cost of the dipping. In that respect, the conditions are not comparable at 4556
all. In my experience paint does not protect pipe. Mr. Mulholland says that the Los Angeles water is so alkaline that it will not attack the steel, and for that reason it does not need the coating, and he is justified in eliminating the dip. It would not do to eliminate the dip in San Francisco, so that that is not comparable. This work was for very large pipe, 11, 12, and 13 feet in diameter, done in an entirely different way, and under different conditions from the Spring Valley pipe; the plates were a great deal thicker, and while we have some idea of the extra cost of handling thin plates as compared with thicker ones, the method of correcting the figures is not an exact one. Taking it altogether, it seems to me that the evidence as to the cost of making these pipes is so very wide of the conditions as they exist in the Spring Valley system that it can be given only a limited amount of weight.

CROSS EXAMINATION BY MR. SEARLS.

It is true of the thinner pipe that it costs more per pound in fabricating than laying it; as between ordinary ranges in size, I do not think there is very much difference per pound. When one takes 132 inch pipe as a basis for getting at the cost of making 32 inch pipe, it is a pretty wide range. I am not sure that the figures for one would apply to the other without very substantial amplification. I should say that they would not apply. It would not be a fair basis for estimating. 4557

Mr. Dockweiler: In the Antelope Valley Syphon the material was hauled over 30 miles by wagon, at $30 a ton. I do not know what size teams they had, as I didn't see the hauling.

Mr. Hazen: There is another item that I would like to add to 4558
my last answer; these are reputed to be the direct costs of the work, computed on the aqueduct's estimate of the weight; the indirect cost of this work was very large. I have never succeeded in getting from anyone an adequate statement of those indirect costs, but on such information as I have I believe that a great deal of what is carried in the aqueduct as indirect costs ought to go into this cost account before these figures could be used as a safe basis for estimating any other work. How much ought to go in I have not been able to ascertain. In checking my estimate as to cost of making the Spring Valley pipe, I have put these figures in the schedule of information as to cost.

Questioned by Master.

In speaking of indirect costs, I do not mean what is ordinarily called overhead. The basis of doing work that I have in mind is

where most of the work is done by contract, and where the estimates of the contractors, and all of the materials that are bought, and everything that goes directly for material and labor is the primary cost of the work; all the engineering, inspection, administration, and all the legal advice that is necessary during construction, is overhead; those two are separated in a perfectly clear-cut way. On the Los Angeles work they kept data on a different system. It was not done by contract—except contracts for the purchase of materials. They put in what
4559 they paid for these steeel plates, and the wages of the men who were directly engaged in doing the work, and some other things that were directly chargeable to this work that went in as a direct cost of the pipe. They had an account for indirect and incidental expenses running into a great many millions of dollars which were not charged in any of those unit prices, but was for labor and material necessary in the prosecution of the work; it was not overhead, but it includes the overhead. In their system they did not separate charges as between the engineers and the men on the work, foremen, etc. I do not know how anyone can separate it on the lines that we used and those in Los Angeles. The whole thing was kept on a different basis—it may be a better basis, but it is a different one, and it cannot be compared with the basis I have used. I do not think the Los Angeles accounts put these indirect expenses into overhead; I think they called them indirect expenses.

Mr. Metcalf: Auxiliary expenses is the phrase they used, and those with overhead costs, but excluding interest during construction, amount, as I remember it, to about 33%. Into that went the cost of the road and the cement plant, and various other construction costs incident to the work as a whole, but which could not well or readily be separated. The 100 caterpillar engines were very likely put in that account. I doubt if in this hauling cost there was included the ma-
4560 chinery or the plant which may have been used in hauling, and which was subsequently abandoned. I think that went into overhead.

Mr. Dockweiler: The cost of the roads I am satisfied are not in the auxiliary expenses.

Mr. Hazen: All roads that are necessary to build are in the estimate, and in a few cases it was necessary to build roads in the Spring Valley system; for instance, in connection with the syphon work on the Pilarcitos line, bringing the water up from Pilarcitos. There was
4561 a road built for the purpose of that construction, and it disappeared after the construction was finished. It would very likely not total over a mile in length.

In regard to the Los Angeles data, there was not any contract price for pipes fabricated and delivered, except perhaps the Dove Spring Canyon. The others are for the contract price of the steel in Pittsburg, with the freight added, and with the labor, and so on, supplied by Mr. Mulholland, added, and all computed on an estimated

weight. I think all the riveting was done on the ground. They actually made up the pipe from the plate on the ground, and never transported the pipe a foot.

Questioned by Master.

My conclusion would be that due to the system of accounting on the Los Angeles aqueduct, those costs are not likely to be of benefit in engineering estimates generally, unless they are studied out and 4562
analyzed in great detail. If those pipes had been more nearly comparable in any respect to the Spring Valley pipe, I would have gone down and stayed with Mr. Mulholland for quite awhile in order to find out a good deal more about it, but it seemed to me that they were so widely different in all their essential conditions that it would not throw much light on this problem. I recognize that Mr. Mulholland is a marvelous organizer; he put this work through in a wonderfully creditable way, and very cheaply, and deserves all the credit he has got, and will get for it. It is a wonderful piece of work, but I do not think it can be taken as a measure of the Spring Valley system. The peculiarities of the cost accounting is simply an added handicap; if it was worth the game, and we spent enough time with it, I have no doubt it could be straightened out so that it could be used, but I have not taken the time in this case.

CROSS EXAMINATION BY MR. SEARLS.

I would not say to disregard the Los Angeles data as a check in my report. I know that some work is done very cheaply, and some very expensively; it is right to know all that can reasonably be brought into the field of view about all these works; it does not follow, however, that the cost of any one piece of work, either high or low, is to be taken as a measure, or as a direct basis of estimating. I have taken the average of some of these costs as supporting data. 4563

I did not make any analysis of my 75 cents a yard excavation cost. That is just my opinion as to the cost of excavating and backfilling, and in checking that I had in mind all the experience in trench work that I have had. I have not had any experience in trench work on the Pacific Coast, and labor conditions are different here than they are in the East. I think that the cost of the trench work is a little more expensive than corresponding work and materials would be ordinarily in the East, with eastern labor conditions. The difference is not very great. The labor costs are greater here, but the climate is more favorable, and that offsets to a considerable extent the increase in labor costs. I had in mind that machinery would be used in excavating trenches, as far as it could be done advantageously, and as far as machinery was developed during the period from 1907 to 1914. I think on almost every important pipe line work that I have had to do with some attempt has been made to use machinery in excavation, and it has been more or less successful. I have never had a case where

4564 the whole work was successfully done by machinery, but some parts of it have been. I didn't find any ground in the Spring Valley pipe line which would indicate especially difficult excavation. It runs mostly through clay, loam, adobe and sand, with about 2.15 percent of hard rock on the outside part of the system not including the distribution.

I obtained some records at Seattle of finished work, which I used in checking my judgment as to the 75 cents. We got some cost records very recently at Victoria. I did not make any inquiries as to the costs in the neighborhood of San Francisco Bay.

Questioned by Master.

4565 Referring to an item of $1.52 a cubic yard, appearing in Mr. Lawrence's data: I should say that in the cost of the San Andres 44 inch pipe, and the Alameda 54 inch, that all of the latter, and a large part of the former was in the state road, and doing the work in the state road costs more than doing it elsewhere. I think Mr. Lawrence has probably included the extra cost, or a great deal of that extra cost along the road in his excavation, whereas I used the same price along the state road, and added 75 cents a foot for the extra difficulty. As an off-hand explanation, I should think that that would probably account in a large measure for the difference. I think perhaps also he used the old labor schedules and brought them up to date, and if he did that, I think that would give a figure a little higher than I should use, because that increase in labor cost has been accompanied by some improvements in method of work, and that would tend to offset some of the increased labor cost.

RE-DIRECT EXAMINATION BY MR. GREENE.

4566 I reckoned the accessories on a percentage basis primarily because that is the method I have been in the habit of using. There is a reason for it, growing out of the fact that accessories are mainly buried in the trench, they are things that the engineer who builds the pipe encounters as he builds it and pays for it, and when the pipe is done they are buried; it largely represents materials that do not show after the trench is backfilled, and that would not ever naturally be included in a schedule of the property afterwards. The percent varies somewhat on different lines, according to where the line is, and the kind of ground that it goes through, and the way it is built. I ordinarily used the figure 10% for outside lines—country lines—where there are not any special difficulties.

Questioned by Master.

It has sometimes been done that varied work is included in general overhead under the title of omissions, but I do not figure overhead that way. I mean by overhead, not any part of the construction work, but the inspection, supervision, and the administration.

RE-DIRECT EXAMINATION BY MR. GREENE.

I referred to 3 or 4 examples where I reached a percentage fairly comparable with the one I used in this case, but I have not been able to find any Spring Valley data directly bearing on that. The nearest that I can come to that is to compare the reputed cost of the two last important lines which the Spring Valley laid, and a few other lines, with the estimates I have made; that has an indirect bearing on that question, and I have those figures.

In 1908, 28,890 feet of 44 by ¼ inch pipe in the San Andres line; 4567
I estimated the cost from the contract prices, with a few items missing, which I estimated as well as I could, $9.51 per foot as actual cost without overhead, and as reported to the Board of Supervisors for the years 1897, 1898 and 1899, the cost of this work was $299,551.23, or an average of $10.38 per foot. I presume that includes some overhead. My estimate for that pipe was $11.90 per foot. That work was done at a period of extraordinary low prices, and I believe was the cheapest pipe work that the Spring Valley ever did.

In 1902, 16,758 feet of 54 inch by 0.275 in the Alameda line, from contract prices, and from Mr. Lawrence's record of the cost of laying, with a few items estimated by myself, $17.60 per foot, as the approximate actual cost; the cost as shown by the Spring Valley books was $347,202, equal to $20.60 per foot. That I assume includes the overhead; the first figure does not include the overhead, and there may be some items omitted. My estimate for that is $15.80 per foot, and I think that was the most expensive piece of work that the Spring Valley has done in recent years. There was a line in 1908, 1,421 feet of 36 inch by 0.203, with a little ¼ inch, laid to accommodate the Southern Pacific near Newark, in connection with a change in the railroads, and this was billed to the Southern Pacific Railroad, and paid by them, and does not appear in the Spring Valley accounts. That line cost $9.85 per foot complete, and my estimate for that size pipe is $8.60 per foot. The Pleasanton line I put in at cost in my estimate, which was about $3.10 per foot. Those are all the records of recent pipe laying, up to the line through the park, that I have. I understand that includes auxiliaries and everything. 4568

I did not intend to say that I did not talk with any people in San Francisco concerning labor conditions, as I certainly did do so. My information as to labor conditions came from inquiry as to the payrolls, the hours of labor, and the efficiency of the men. I inquired of all the Spring Valley people who were conducting work, and I met in various ways many other people who were doing work in California, and I compared in my own mind the result that I got, with the conditions of labor as I have known them in other places. The sources of information that were available to me were sufficient to satisfy me as to the conclusions which I reached on that subject. More recently,

after my estimate was made up, I had from Mr. Hood copies of a great many Southern Pacific payrolls running through quite a term of years, and they show a great variation in the price paid for labor at different times. I think the fluctuations have been rather wider in California than in the East; that is, when things are good, men are
4569 hard to get, and the prices go up a good deal; I am speaking of temporary work where the men are taken off and put on repeatedly. On the other hand, when work is dull, and men find it hard to get work, the rates of wages go down a good deal.

The cost of fabricating pipe depends upon how it is done. If pipe is made under an adequate plan and specification, and with adequate supervision, it will cost a great deal more than if it is done in a less perfect way, and I should give no weight whatever to a simple quotation from a manufacturer that was not tied up in some way. Further, a quotation of that sort involves no liability to the one who makes it; he cannot be held to it. If bids are called for later on, and he bids for it, as in my experience he often does, he says that work is different than that on which he figured, and he is probably right. Then to make an estimate of that kind to be worth anything, involves an expenditure of time and money of at the very least several hundred dollars, and perhaps a good deal more; if there is an actual bid in prospect, a manufacturer of course will make estimates ade-
4570 quately in that way for the purpose of preparing his bid, but if the inquiry comes simply in the matter of friendly information, it is hardly to be expected that he will take the trouble to make a very careful estimate of that kind, especially as it involves no liability to live up to it if the work proceeds. I am speaking from experience; not relative to these quotations, but relative to others. I have frequently had the experience that manufacturers have told me that certain things could be done at a certain cost, and then when bids were asked for, they have been very much above their preliminary estimates.

Mill inspection is essential in the pipe that I have had to do with, and it is customary. It has always been done in the case of the Metropolitan Waterworks in New York, or in Boston, or in Roches-
4571 ter. In a general way the plans and specifications are one instrument. The specifications are the words, and the plans are drawings, and they together form a complete description, which ought to be perfectly clear-cut and definite, showing just what work is to be done, so that the bidder will know just what he has to do for the money that he is to receive. A specification as to quality is very apt to result in an increase of cost. The more you specify, the more it will probably cost. I find that Mr. Schussler's requirements, as far as wrought iron pipe was concerned, were very rigid, and I think that in the case of reproduction that would result in adding to the cost. Those requirements were, in my opinion, justified.

Questioned by Mr. Searls.

I do not mean to say that I would reproduce this pipe according to the exact specifications from which Mr. Schussler did, but I do 4572
mean to say that Schussler's policy of having a fixed specification, and enforcing it, was a wise one, and resulted in getting better value for the Spring Valley Water Co. than would have been possible if he had not done it. I do not think the enforcement of such a policy resulted in any increase over the kind of specifications that have been used in the East by men like Kuichling and Herschel, that have been used in the Boston and New York, and Cincinnati, and Louisville Waterworks, and a great many other of our eastern supplies. There are two fundamental points of views looking at these matters. You will find a great many old school men whose point of view was, first do the work well, and then do it as cheaply as they could; you will find another point of view represented by the desire to do the work cheaply, and then if it does not cost too much, to do it well. That is a fundamental difference in the way that different engineers on different principles have looked at these things, and it makes, undoubtedly, a great difference in the cost of the work, which point of view he takes.

RE-DIRECT EXAMINATION BY MR. GREENE.

Referring to the Pleasanton line; it is very much cheaper for a particular use as a conduit, and may answer just as well, but if it is wanted for pipe under pressure, it isn't worth anything like as much. 4573

It is true that if the dipping were perfect on a pipe, the metal continued to be coated, all of it, all the time, the durability of the metal back of the dip would not be a matter of much consequence, but as a matter of experience, coating never covers all the pipe for any great length of time. The metal always rusts and corrodes more or less, notwithstanding the coating, so the coating reduces the corrosion, puts off the time when it appears, but it does not stop it, and the desirability of having metal that will resist corrosion back of the coating is still very important. I do not think that steel would have lasted as long as wrought iron in this system, even if it had the Schussler coating. 4574

I think the excavation at Sacramento is easier than in San Francisco, because the material I saw some years ago at Sacramento was soft enough to be dug very easily, and it is also firm enough and cemented enough so that it stands perfectly without any bracing, even in quite deep, narrow trenches, so that the conditions of excavation are almost ideal; that does not apply to all the excavation in Sacramento. I saw some places where the digging was hard there.

It is possible to enforce specifications, rigid though they may be, for the making of riveted pipe, and I have done it occasionally.

RE-CROSS EXAMINATION BY MR. SEARLS.

One of my early sources of information as to labor costs on the Coast was an acquaintance in New York who took contracts in San

4575 Francisco for a number of large works after the fire. I do not say that the labor costs after the fire are to be taken as the standard of Pacific Coast labor costs, but I was very much interested in his telling me about the relative efficiency of labor, and the means that he used to get the men in San Francisco to do the kind of work that he was in the habit of getting done, and did get done. I have talked with a great many people, and I have been looking for information all along the line. I do not concede that Pacific Coast labor is more efficient than that in the East, and I have not found a great many people on the Pacific Coast who were of that opinion. I do not think that shorter hours and higher pay add anything to the efficiency of labor.

Mr. Metcalf: I have not wanted to state this for the record, but merely as a matter of information: We looked that matter up at the time of the investigation for the Boston Finance Commission, and we found that the City Engineer had kept reports for a number of years
4576 concerning what he called a typical piece of work, in order to get a line on that very thing, and he found not only had there been an increase in the rate of wage, and decrease in the hours of labor, but there had also been a falling off in efficiency even under the shorter hours of day, and that one of the most probable explanations of this seemed to us to be the fact that there is a certain amount of loss of time in getting to and from the work, and during the day, and that becomes a larger percentage of the total productive time where you have the shorter day than the longer day. That refers to city work in Boston, and was in the waterworks department.

Mr. Hazen: I do not think of a case on the Pacific Coast where the bids went above preliminary estimates, where the estimates were based upon specifications. I know of a very significant case in Australia, and human nature is a good deal the same all over the world. Oftentimes a man gives you a low price for the sake of getting you interested, in the hope that you specify his contract, or draw the specifica-
4577 tions in a way that he will get the work, and that would apply where you were going to build pipe according to your own specifications. In Australia I was making an estimate for some 30 miles of steel pipe, and there was one large pipe shop in Australia that has made most of the pipe there; they gave me a preliminary figure for this pipe, and I went to the works and met the owner, and he told me what he could make that pipe for; I went home and estimated at a very much larger figure than he gave me, and when they got bids for the pipe under the specifications a year or so later, the bids slightly overran my estimate. These men are constantly coming to our office in New York, and telling us about methods and materials, and how cheaply they can do the work. That information is unreliable, and we do not pay any attention to it at all. Of course, if you go to a reputable manufacturer who is making cast-iron pipe, and he tells you he can supply pipe at $24 a ton, that means something, but a quotation on things, the cost

of which varies with the plans and specifications on products along a great many lines, do not mean anything at all. If I were to give a pipe manufacturer a pretty fair idea of my specifications, and he wrote me a letter setting forth figures at which he said he could and would build it, I would not consider that a fair estimate of the maximum that I would expect to get under a bid from that manufacturer. 4578

Witness: LEONARD METCALF for Plaintiff. Metcalf

DIRECT EXAMINATION BY MR. GREENE.

The New Bedford pipe was not nearly in such good condition as the pipe of the Spring Valley Co. which I walked through last year. It has tuberculated much more, and is much more pitted and blistered. 4579

Questioned by Master.

The blistering is in the coating. We find in the steel pipe lines, often, on the inside of the pipe, blistering varying from the size of your thumb nail to even 2 inches or more in diameter, and when you break those you find an alkaline liquid in them, and for many years the plate will be perfectly clean, and not corroded. In the case of the New Bedford pipe line, we did find some of the metal underneath those blisters beginning to corrode slightly, and Mr. Merriman, who went into the pipe line with me, was rather of the impression that there were more of them on the occasion of this last visit than on the previous visit five years before when he had gone through the pipe line.

DIRECT EXAMINATION BY MR. GREENE.

I have not made any estimate of the cost of reproducing the wrought iron pipe in the Spring Valley system. When I came out here I had expected to do that, but I found that it was physically impossible for me, with the other work which I was called upon to do, in the assembling of the data and records, and in the making up of the inventory, to make a detailed estimate of all these structures. I have gone over his figures with Mr. Hazen, and with the other engineers their figures, so that I have had familiarity with them in a general way, as well as having made a careful inspection of various parts of the property. I have made certain check estimates, as for instance the reproduction cost of the distribution system as compared with other systems, with which I was familiar, as a means of checking 4580 quite independently the results arrived at by Mr. Hazen; so that I could pass upon his reproduction costs from my own point of view, when it was completed, because I wanted to be prepared to pass upon the value of the property as a whole, and one of the yard-sticks which I wanted to use was reproduction cost. I have done that, and come to the conclusion that Mr. Hazen's estimate as a whole upon the reproduction costs comports fairly with my own views, and I have so accepted those figures, but I have not made a detailed, independent esti-

mate of the reproduction cost of the structures. It was my thought that it would be more helpful to have the estimates of the local engineers, and the witnesses from the water company, as Mr. Lawrence on the original cost conditions, Mr. Elliott on the distribution system, Mr. Hermann on some of the earth dams and flumes, and Mr. Lippincott and other parties on certain portions of the schedule. For those reasons I did not make a detailed estimate of the reproduction cost of the wrought iron pipe.

4581 Questioned by Mr. Searls.

I have not gone so far as to corroborate each and every detail of the reproduction cost figures of Mr. Hazen. I have taken the pipe system for instance; I have worked out in detail the cost per ton of pipe that was in Los Angeles and across the bay, and various other points. The valves had similar figures which I worked up, and which I discussed with Mr. Hazen, and with reference to the figure which he finally adopted, they seemed to me fair. I have gone over in a general way his figures upon the distribution pipe system, but I cannot say that I have gone over in detail every single item of the schedule. I took the results which he arrived at per mile of pipe, and made certain comparisons on those. Similarly on the pumping plant, I considered the result which he got on the basis of prices per pound of metal per million gallons capacity, and per water horse-power, which are the three units which I have been in the habit of using in discussing such results. I did not go into all the details which made up his schedule of the pumping station. I have taken certain other schedules in that general way, to check them as a whole, and to see whether they were in general consonance with my views, rather than to go through

4582 each item of the thousands of items in this schedule.

I looked over Mr. Hazen's appraisal, and checked certain items of it, and finding that it seemed in my mind to be based on reasonable grounds, I accepted that as a whole, and my testimony is not to be taken as corroborative on my part of all the details there made after careful investigation of each of those details. I have checked his figures, however, not alone as to certain isolated items, but the figures as a whole. I have not attempted to corroborate all of the individual items making up his schedule.

Referring to wrought iron pipe, I do not say that I corroborate each of the items which Mr. Hazen has made; I have read what he has written on this steel and wrought iron pipe question, and on the riveted pipe. I worked up individually the Los Angeles results. I saw the same things, or many of the same things, which he saw on the trip to the North. We had figures from the engineers there; he showed me the figures which had previously been sent to him by Mr. Clark, so that I was able to form a judgment, I think, as to the fairness of his estimates as a whole, and his estimates upon the riveted pipe work seemed to me fair.

I do not think that the Los Angeles aqueduct costs are to be 4583
taken as a fair basis in this case. I agree with the statement which Mr. Hazen made this morning with regard to the difference in conditions, and the difficulty in making direct comparisons. I have never constructed, or superintended the construction of any water system, or parts thereof, in the western states, and my familiarity with the prices of labor and materials out here arises solely from the study of the records, and information.

Witness: J. H. Dockweiler for Defendant. Dockweiler

DIRECT EXAMINATION BY MR. SEARLS. 4584

This is data on the cost of fabrication of certain pipe taken from 4585
the records of the Los Angeles Water Department, by the J. G. White people. It shows the cost of the pipe delivered at Los Angeles; not for any aqueduct work, but for the water department work. It is for steel pipe. I have not used this in my own figuring. I have just obtained this sheet within the last week. This is only data that would substantiate my own figures.

Questioned by Mr. McCutchen. 4586

I understand that this data was obtained by J. G. White & Co., at the time they were making a valuation for the Spring Valley Water Co. It was given to me by one of their men; I do not know his name, but I know he worked for the J. G. White people.

CROSS EXAMINATION BY MR. MCCUTCHEN. 4590

I have prepared plans for pipe other than for the pipe which I laid in Los Angeles while I was City Engineer. There were plans and specifications gotten up in detail for the proposed waterworks for the City of Los Angeles. That was in full; a complete set of plans and specifications for that work, and accompanied the report I made in 1897. I could not state whether any of the pipe referred to in those plans and specifications was ever made. I would not be positive whether those plans call for the inspection of the pipe while it is being made. I am satisfied that I followed the standard practice at that time. As to cast-iron pipes, we just simply specify the class as given, and the weight, and whether wrought iron or steel. It would depend whether there was a difference between the cost of fabricating pipe under rigid specifications, and the cost of the fabrication of pipe carried in stock. Nowadays there is very little riveted pipe carried in stock. I do not know of any stock pipe that is carried; it is all made to order, outside of a little irrigation pipe.

After specifying the character of the metal—when pipe is made to 4591
order—you specify the size, and give your rivet spacing for the round and longitudinal seams, and you specify whether these rivets should be driven cold or hot; then you specify for your calking, and for your

test and your dip. In preparing specifications for the fabricating of a pipe line of the size of the largest line used by the Spring Valley Co., I would provide first for the metal as it is in the pipes, using the specifications that were employed, and I would expect to get a plate fabricated equal in quality with that the Spring Valley used. After I had gotten my plate, I would call for the rivet spacing, and how the rivets should be driven; I would call for the calking; then there would be the test; then the dip would be put on after the pipe was made. If you tell the men the material they are working under, and give them the rivet spacing, and the head the pipe is to stand, or the working pressure, they will know then the rivet spacing. A rivet is driven the same whether it is put in as a shop job or anything else. To illustrate: Those rivets are driven by a bull machine. You put the pipe right under, and it does not make any difference how big the job is on a rush, it is driven; the close spacing of the rivets, and the distance of those rivets from the end of the plate, determines the tightness of the
4592 joint for the same class and weight of metal. The object of the calking is to bring the plate to a tight seat with the opposed plate, so that there will not be any room for leakage.

The riveting would be done in the same way, whether there were specifications, or no specifications. They could not do it any other way. A shop is arranged this way: Most conveniently the track lies parallel to the shop; the plates are unloaded off the cars at one end of the shop. That plate is bought to size. The first operation after it arrives in the shop is that it is put on a little platform which carries the plate in between two punches which are parallel; these punches in a big establishment are so arranged that they can punch the opposite sides of a plate when they are only three feet apart. In other words, they can punch rows of rivets only three feet apart; they are so arranged that they can be stretched out from 15 to 17 feet. These rivets spaces are fixed. You put that plate in, and each side is under a punching machine. Automatically, after it is started, the machine punches the holes, and a contrivance shoves the plate ahead so that the next holes can be punched, and for a plate 12 feet long it will go through this machine in less than a minute. Now it is obvious whether the space is
4593 10% closer, 20% or 30%, after the machine is once set, the time employed in adjusting the plate is the longest; it goes through the machine with a rush. That provides for the double seam on the long end of the plate. Then there is a device put at right angles to the edge of the plate, at the proper distance back, which is in the shape of a long piece of metal with holes punched in at the proper distance, which you have provided for in the rivet spacing; a man goes with a punch and punches each one of these plates for the purpose of enabling the man who punches the round seam to get the proper spacing; so that the detail of the number of holes is practically negligible. Then they have another machine in which the dies are set, and you can punch the

two rows of holes on one edge of the plate at one operation. This set of dies costs you $350. A long established shop has almost an inconceivable number of rivet spacers. This is a powerful machine, and will punch all those holes at one operation, and it does not make any difference how long your plate is. That is the preparation of the metal for the holes; then it is put through the bevel-shear so as to give it the bevel and cut-off; then the man scarfs the corners of the plate, and then the plate is put through the rolls and given the proper curvature.

From there it is taken and pinned up, so that the holes are pretty nearly opposite each other, and with a ribbing machine the burr is taken off on the under side of the sheet, bringing the two holes in one line. Your cylinder is now ready to go to the bull machine. There are a set of men working here, one has a machine that heats the rivets; another works the hydraulic press on this machine; another man turns that, and another man shoves the pipe ahead so that each hole gets under the rivets in the machine. That goes as fast as a man can pull the hot rivets out. If there are 10 holes to the foot, or 12 holes to the foot, or even if it is still closer, that is the only element that comes in as to whether your pipe is made tight or not; if that machine only puts in one rivet to the foot, or 20 rivets to the foot, it brings those rivets to a seat, because on the inside of the pipe a device comes up and works against the top part of the die so that the two plates are brought together, and then the heads are put on. After the pipe is thus made, it is rolled along until it gets to the man who is running the calking machine; he rounds off the corners where the round seam and the long seam meet. Then he runs over that with a tool, at least two times; the first time he goes up one end, and the next time he goes down. When he is through, the pipe is chipped and calked. Then, if you care to, you can have the testing. They just take a few pipes out of an order and have the test applied to them. From there it is 4595
fabricated, and goes to the dipping trough.

I recognize that there are such things as rigid specifications for the fabrication of pipe. I could make up finicky specifications for pipe that would break any contractor. When a man is on the inside of the pipe you want to have your inspector there to see how he drives that rivet, and anyone could tell at a glance that that would interfere with the men. It is hot and close on the inside of the pipe, and the ordinary man judges of a rivet after it is driven. He can tell whether that rivet is loose or not. I do not think that that would be absolutely unnecessary to make good tight work, but I do say that a man can be finicky and put a man to a lot of trouble.

Questioned by Master.

I do believe that there should be this inspection of riveting from the inside, but a man could be kind of testy about it. I would be

reasonable. I have had work done for me, and I have also acted as engineer for contractors—I have been on both sides of the fence. If necessary, I certainly would provide for the inspector on the inside.

CROSS EXAMINATION BY MR. MCCUTCHEN.

4596 I would specify that the joints should be properly made, and an inspector would have to go in and see that that was done if I called for inside calking. I would keep him on the inspection job all the time while the work was being done, and would think it very bad practice not to do that. In the specifications that I prepare, I would say "Inspection sufficient to bring results"; the results would be a tight barrel or tube. I should provide in my specifications for proper inspection, but I would not provide each step that
4597 an inspector should take. In the shop you would examine first and see that the plates were proper before they were even fabricated; he would see whether there were any defects on a plate, and if there were, he would notify me, and I would size him up and see if he were a proper inspector, and if his judgment agreed with mine, I would reject the plate. In this case I am assuming that the company furnishes the plates; the plates are assumed to go to the shop man just the way they have in the past. The company has bought the plates. I would want a contract to know what I was going to get, and what I would bring about in the contract would be this; that the inspector would see that the plates had been rolled, that there were no defects, and if defects turned up, he would have that
4598 plate put aside. After describing the work that is to be done to the man who is to inspect it, you would tell him that you would expect certain results, and that you would want the thing to comply with a certain standard, and so on. I cannot exactly recall what I would say with reference to an inspection, but I would insert clauses sufficient to produce for me a pipe such as I had in mind.

I cannot recall now just what instructions I would give to my inspector. The fact that I provided for an inspector would not re-
4599 sult in additional expense in the fabrication of the pipe. A good shop always invites rigid inspection, but there is a difference as to what rigid inspection means. If it means an inspection to bring out the best that can be done, that is one thing; if it is a finicky requirement, where there is not anything that goes to the substantial nature of the work, where, for instance, if you called for a specification that when the edge is beveled it should measure exactly to within .01 of an inch from the center of the rivet holes, you could do that, but at enormous cost, and it would not add anything at all to the efficiency of the work; it would be in the nature of calling for the sandpapering of a brick wall. A man might look at a rivet head, and say, "The tops of all these don't exactly line up", although the rivet might be perfectly tight, but he would say, "Just

pull that rivet out". That is a case of finicky inspection. You don't ever state in your specifications that the heads of the rivets should line up, you just specify the punch and the size of the rivet; the machine makes the rivet head on the other side, but the in- 4600
spector would have that chance at the men, and another thing, he might step in at a certain process, and say, "Step aside, I want to look at this"; whereas he could have waited just as well until they performed a certain other function, and then he could look at it. That would cost something, and add to the expense unnecessarily. A good inspector does not cause any delay unnecessarily, because every man that is in shop work expects to have his work inspected, and he tries to lay out his work so as to interfere as little as possible with the movement of the material in course of fabrication. Every first-class shop expects to have his work inspected.

I have heard of under-riveted pipe, and it generally means that the rivets are not close enough together. Generally speaking, your 4601
rivet is double the thickness of your plate, and if you use ¼ inch plate, you use the thickness of a ½ inch shank rivet. Under-riveting is when it is not close enough together; the rivets may not be large enough, and the lines of rivets may be too far away from the edge of the plate, so that there is not stiffness enough in the metal; in other words, there is such a big space that you cannot calk pipe. There are rules given for riveting, but offhand I cannot tell you any more definitely than I have what an under-riveted pipe is.

I have not seen the Pleasanton line, because it is covered up, and I never examined it with the idea of seeing whether it was under-riveted or not. I understand it does not run under any pressure at all, say not to exceed 4 or 5 feet head, and you could just pin it together with the earth, and there would not be any leak out of it at all. If I were laying a pipe line, I would be willing to accept pipe made as that Pleasanton pipe was for that purpose. 4602
I would not, if it were under pressure. It depends entirely on the head that pipe is expected to work under, and that will determine two things; the thickness of the plate, and the size of the rivet. If I were ordering pipe to be made to be used under pressure, I would not permit it to be made as that Pleasanton pipe was made. It is fair to state that if that pipe cannot stand a 100 foot head, or a 20 foot head, I would not permit it. I have not examined the rivet spacing. I know that the Pleasanton line is composed of two sections; one is the old Pilarcitos pipe line, and the other is that new piece. I did not examine the rivet spacing on the line made by Francis Smith at all. Mr. Smith informed me that Mr. Bourn called him to his office, and told him that he wanted him to make a pipe to carry water between points, and outlined to him the duty that that pipe would be called upon to perform. He asked, and received a figure from Mr. Smith, and then said, "Go ahead and build it. You

built lots of pipe for me up in Grass Valley, and your work is good
4603 enough for me". There were no bids called for on that pipe, and I am satisfied that it meets with its requirements. I do not want to be put on record as attempting to judge the Spring Valley pipes by that pipe, because I have treated it under the conditions which surround it in my valuation. I do not think it is comparable to the other pipes of the Spring Valley Co., nor that it was fabricated to the Spring Valley standard at all. My present appraisal on that
4604 pipe is $2.82 per lineal foot. I gave 5¼ cents per pound for fabrication on that. It weighs 40.6 pounds per foot.

Mr. Hazen: I gave about 37.

Mr. Dockweiler: I took it at 40.6, and figured it at the trench 5.46 per pound; that made $2.21 a foot. I made it 30 cents for dipping, which made $2.51, then I allowed 30 cents for laying which made $2.81, and I called it $2.82. That is undoubtedly high, but that is my figure. Of that, 4 cents per pound is for plates. The fabrication is 60 cents per 100 pounds; shop overhead 50% of the labor, which is 30 cents per 100 pounds; 50% profit on the labor
4605 and shop overhead, which makes it 45 cents per 100 pounds, and that, with the metal itself, gives you 5.35 per 100 pounds, or 1.35 for the fabrication alone. That is comparatively thin material. 60 cents a hundred is the exact shop labor, and your shop overhead on that, which includes depreciation and incidentals, is 30 cents per hundred, which makes 90. Then you take 50% profit on that, and that gives you $1.35 per hundred for that size plate, and that completes the length of pipe in the shop, to which you must add your dipping. That is what I have allowed for the fabrication of that Pleasanton line, and it is quite as much, if not a little more, than what I have allowed for the fabrication of the best pipe in the Spring Valley system, but in the rush here we applied the price on what I call standard Spring Valley work to that job, and to that extent my valuation is too much, but I am willing to let it go. If
4606 I didn't expect any more from the Pleasanton line than it is performing now, I do not see why I would put in any other kind of pipe. I knew the contract price, but this is an estimate made for the standard Spring Valley pipe; in applying this unit price, I went through it, and I am at fault there. I knew the contract price very shortly after the contract was let, and should have realized that my price was too high, because I knew Mr. Francis Smith who built the pipe, and he explained to me just what kind of a pipe he built. My figures are not below the contract price. It is my impression that that pipe was $1.90 a foot.

My figures are $2.80 in the ground. My price on the ground, undipped, is $2.21; dipped, would be $2.51. You only paid $1.90, so I am 61.7 cents over. The price of $1.90 was what Francis Smith got for it, and the company had to lay it itself, but as my estimate

was $2.82, it allows 92 cents for laying and transporting it per lineal foot. I do not recall now what the actual cost of the pipe was including the laying and transporting. 4607

On 44 inch pipe I allow 40 cents per hundred—that is ¼ inch; if it is 3.16 inch iron, I allow 50 cents a hundred; then you add 50% overhead, and that makes 60; then you take 50% profit which gives you 30, and altogether that makes 90; so for the fabrication shop work on 44 inch iron you allow 90 cents per 100 pounds for the shop work without dipping.

I do not recall that I ever figured on the riveting of any of the Spring Valley lines as to strength as compared with the strength of the plate. Whether it was under-riveted or over-riveted, I took 4608 the rivet spacings as they are, so I did not need to worry about that at all, as the pipes have been holding; I might have had a formula that would prove that the pipes would not last, and the formula wouldn't be worth anything because it is lasting. I recognize a difference between buying on weight and on gage; in buying on weight you determine the thickness of your pipe; buying on gage is the minimum thickness of the plate, and you can safely figure that at every place else it is at least that thick and a little more. I agree with Mr. Hazen that it is safer to buy by gage, as you are assured in that way that your plate will have that thickness as a minimum. If I were preparing specifications for the manufacture of plate into pipe, I would specify that it was to be bought by 4609 gage. I do not recall whether I made any such a requirement in the specifications for the Los Angeles Project.

Questioned by Mr. Searls.

When we get to specifications in the Richmond case, I shall prescribe buying by gage. In the specification No. 268 for steel and rivets for 5 riveted steel syphons, they specify thickness ¼ inch, 5/16 of an inch—they specify nominal weight. They do not specify the gage, but all contractors in submitting their bids, submit a total weight of plates and rivets. I have not gone through these specifications in detail, so as to determine whether that means edge thickness of not. It does not state here that it means the thickness 4610 of the plate at the edge. It says nominal weights 10.20 pounds.

Questioned by Master.

These are specifications No. 268, steel and rivets for five riveted steel syphons on the Los Angeles Aqueduct.

CROSS EXAMINATION BY MR. MCCUTCHEN.

These specifications are drawn on a weight basis. You have got to have a beveled edge so that you can calk your plate properly. If you do not have it done before it gets to the calker, he has to do it himself, and that is what they call chipping. If it were not required in the contract, it would not be done, but if you stated to

have your pipe chipped, and specified an angle of the chipping or shearing, that would cover. The best shop practice calls for shearing plates at 45 degrees. They would not shear the plates if the con-
4611 tract did not call for it; you would specify that. You would, naturally, in ordering pipe, have your specifications so drawn as to meet the requirements of your duty. You could make a pipe which would hold water, so to speak, but it might not be considered first-class work. I would make a requirement first-class work, and would draw the specifications to suit requirements. If I was putting in a force main, I would make that stronger than I would an ordinary main that is not subject to the pulsations of a pump. I would specify extra strength because the main was a force main. If I said to the pipe works simply that I wanted a pipe of a certain size to convey water, they would not give me a pipe as well fabricated as if I were to prepare such specifications as should be proper, but if I told them I wanted pipe of a certain metal, with certain size rivets, with the rivet spacing to be so and so, and that I wanted the pipe to be chipped
4612 and calked, and to withstand this kind of pressure, and then I wanted it to be properly dipped, that would give them an idea at least of what I thought would fulfill my requirements. If you did not specify it, and asked simply for a tube, they are certainly going to give you anything that will hold together, but your requirements or specifications are drawn with a view of what the pipe which you are going to fabricate is to be called upon to perform. It is presumed when a man goes and asks for something that he knows he is going to get something. You are not going to send a child to market.

I wrote to Lacy Brothers, and asked them to give me an estimate on pipes of various diameters, but I did not tell them anything about specifications. I had a private conversation with them, and told them, "Now, boys, I want to get the reproduction cost of the Spring Valley pipes", and told them the purpose for which I
4613 wanted that exhibit. I went to them, and told them that I was appraising this property for the City, and I told them, "We are going to have quite a long Hetch-Hetchy pipe line to figure on, and I want you to give me a reasonably close approximate of what I can expect that work can be done for". I did not tell them I was antagonistic to the Spring Valley Co. One of the men thought I was working for the company, and didn't know otherwise until I afterwards informed him. That was after he gave me the quotation.
4614 I do not know what he thought when I was getting this information, but he seemed surprised to know that I was not working for the company. I did not have any other correspondence with him on the subject other than that I have offered here. In talking with him I gave him the heads, roughly, against which he would have to work.

I did not say anything to him about inspection. He is a reasonable man, and knows he would have to build pipe under inspection. He had been given the average heads, because I was not going to lay myself open to get a quotation that would be inapplicable, and I told the engineer of the Western Pipe & Steel Co. the heads against which he would have to work. My impression is that I told Mr. Lacy that the heads would vary from 200 to 300 feet on the 44 inch. I am very sorry that I did not put this in writing. I do not remember whether Mr. Lacy asked me for whom I was making the appraisal. I assumed all along that he knew I was working for the City. Mr. Lacy and I have been friends for many years, and I know him very well. I told him there might be a larger order for pipe for the Hetch-Hetchy System, and I think in conversation naturally, in discussing with men work of that kind, we say well, how are things in our line looking up your way. I do not know whether he thought the Spring Valley Co. had anything to do with the construction of the Hetch-Hetchy. 4615 4616

The man to whom I put the inquiry for information in the Western Pipe & Steel Co., knew that I was making this valuation of the Spring Valley system for the City. My impression is that I told him about the heads under which the pipe were to be used. I am satisfied he had information on that subject, although I do not exactly recall how he got it, but he is an engineer, and knows the pipe technique very well, and the pipe technique required, in order that he might give me an intelligent answer, that he should know the heads under which the pipe was to be used. If you specify a certain thickness and size of plate, that would come pretty close to determining the head under which that pipe will work, assuming the normal rivet spacing. If you give a shop that makes joints at something like 70 to 75 percent efficiency that information, you have pretty nearly given them an idea of the head they are working under. I do not remember how it was that I came to advise about what the head was, but in discussing the matters with them I brought up 200 or 300 feet, and that would be only external. If you tell a man, "I want a 30 inch sheet iron pipe. What will you make it for me for"? there might be some grounds for your objecting to an estimate, but here you are specifying the thickness of the metal and the size, and the rivet spacing is the only thing, assuming proper calking and beveling, that will come in, as I understand it. 4617

Referring to the quotations by the Lacy Co., if you make the violent assumption that a man could submit something to you that would leak, and that did not have even normal riveting, then you would be justified in doubting whether any one of these pipes can be delivered that would meet the description of any pipe that I have specified, and still be wholly inadequate for service in the Spring Valley system, but I am satisfied that this man's figure allows margin

enough so that you could have had fabricated, the pipe that would have complied as to workmanship, at the figures that are given here. That is the general description that will apply to any of your pipes.

4618 A 37 inch pipe, No. 3, to be double riveted and double dipped, and of a grade equal to the best Allan Wood iron, would not, without any further requirement, or any further description, be adequate for service in the Spring Valley system where a 37 inch pipe is used. In building, you would specify your requirements, and their shop practice is such that if the Spring Valley would require two more rivets to the foot, you could have them put that in, because they are assuming proper fabrication of pipe. There is no provision in the Lacy estimate for calking inside and out, but they would also do that if they were to build that pipe; that figure is sufficient for calking inside and out, although they do not so state. Their price includes beveling the edge of the pipe, although they do not say so. They will double dip, but the Spring Valley dip in my figure is entirely separate.

4619 The importance of whether a pipe should be calked inside—it depends. I do not understand that all of the Spring Valley pipes are calked inside. There are just two ways of calking, what you call the ordinary calking, and the split calking. I would not allow split calking, because it has a tendency to split your sheets, and it is not employed on water pipes by the first-class firms. If I were to order 10,000 feet of 36 inch pipe, double riveted, describing the weight of the plate, from a pipe fabricating house, my impression is that they would calk it with an air gun now, as I do not think that there is any difference in the cost of split calking as against the other. You have got to assume that a first-class man is going to figure on first-class work, and when I said to them "Spring Valley", they would know that they would have to do a good job. I am frank

4620 to say that I do not know what was in the mind of Mr. Lacy when he made that estimate, but he gave me a figure, in my opinion, that would permit of the fabrication of that pipe in the way it has been built; that is, that it would produce good work. I cannot see where this great mystery comes in, because a pipe is merely a long boiler, and men have been making boilers since the year one. It is merely the object of bringing the plates together and making them tight, and there are dozens of factories that do it, and expect to do it. I am satisfied you could conjure up impossible conditions, or things that would not happen, but when these men came to build that, you would have your specifications there, and ask them to comply with them. Look at the work that they have turned out for the City of Los Angeles. Those pipes are working today; water and its pressure does not recognize any locality. A hundred pounds of pressure demands the same requirements in Los Angeles that it does here. There are certain basic principles that these men have got to meet

and comply with. They have three companies down there building pipes; Llewellyn, the Baker Iron Works, and Lacy, and the Western Pipe & Steel Co. is four. We have two companies up here; the Western Pipe & Steel Co., and the Schaw Batcher Co., and there is probably Montague who is in business yet, so that between here and Los Angeles you have at least seven shops, and Schaw Batcher has a shop in Sacramento, which makes eight; so that when you have 4621
business that is as good paying as the Spring Valley pipe, you certainly will have a flock of prospective bidders on any work, and the mechanics are all practically the same that they draw on. If one man had a big job of work, and another shop was not busy, he would come pretty near getting those mechanics.

I do not think it a scientific method of valuing a plant like this to ask a house what they would have charged for a pipe order of 5 or 6 years past, but there is no reason for them to go too low, and I used that data merely to enable me to figure along the lines that I was proceeding. I think your criticism would be proper, if I had said why it was worth that price, but I have used that as a part of the data. I consider that it is valuable, and if I had not had it, you would want to know why I did not get it. I would not have felt embarrassed if I had not had it, but a man likes to have quotations from the men that are doing business in that line. A request has been made many a time to a manufacturing house as to what it would have done something for at a past period. For instance, you can go to a lumber concern and ask what has been the price of lumber in the past, and they will try and get it for you; you can go to a cement concern and ask them. In doing that you would tell 4622
them the kind of lumber that you wanted, and the quantity of cement. On this pipe I told them the number of feet, the length of pipe, and gave them the size and the gage. I inquired also from Fred Baker, but he did not go to any trouble, and his figures are much higher than these Lacy figures. I haven't them here; they are in the office. I did not try to get any prices from Eastern manufacturing houses, as they haven't any advantage over the men here. 4623
I did not make any effort to get prices from them, because they would not go to the trouble of giving me any figures, because I am not acquainted with them. I did not communicate with the Allan Wood Co. I did not make any effort to ascertain what they would charge for iron plates, or for pipe made of wrought iron. The cost of fabricating pipe in the East would take a different freight rate when you get it out here, so if you had it made up of pipe, the mechanics out here are just as good as they are in the East, and I would like to give you an idea on that. Generally most of that work is done out of doors, and in winter those plates get cold, and in the morning there is a little bit of ice on it, and the man has to take shavings and clean that off; these men generally have double gloves

for handling that; they have a woolen mit and then a good buckskin glove over it, and if you can tell me that a man can handle that kind of material in the East as efficiently, and do as much work as he can out here, then I don't know what the efficiency of workmen is.
4624 In the summer time, while the men have to handle the plate with gloves in certain operations, they don't have to handle it with gloves because the plate gets hot, but they handle them with gloves to keep the rough edges from cutting them, and the efficiency of the men is not as good as you think it is; in the morning they go to work, and they are affected by the cold, and they have not their faculties good and open. A man here is on the job the moment the whistle blows. Back there he is either roasted to death in the summer, or in the winter time he is trying to get a move on himself to keep from being frozen. I claim the efficiency of labor here all the year around is 20% in excess of that in the East, because you can work a longer day and every day. I know this personally, that a man who has worked in those shops told me that in one day here he could mark out more plate work than he was able to do in two days back East,
4625 and he has worked in most of those shops. San Francisco has the finest mechanics, pays the biggest wages, and attracts the best men. Take the Union Iron Works here. Ship building is a question of plate work nearly throughout, and they can do work here.

If I had a contract of this size, I would have a factory about 60 miles from San Francisco. There are two factories here now; the Schaw Batcher Co., of South San Francisco, and the Western Steel & Pipe Co., of Richmond, and all you would have to do would be to rig these up to handle this special work. I think the Richmond plant works nine hours. Schaw Batcher works eight hours, but they pay at the same ratio. I would locate the plant 60 miles from San Francisco, as I would not want to have any labor trouble. I would
4626 build that factory just for the purpose of building this 21,000 tons of pipe. These people have charged up shop cost now on all their work; they would just bring up part of the equipment, and put up a temporary shop that would not cost much. The suggestion of building the plant 60 miles from San Francisco was one I made to these men in bidding on this work, that they give me the price for fabricating within a 60 miles range of San Francisco. Mr. Lacy certainly knows that if he fabricated within 60 miles of San Francisco he would have to get his plant up, and I am assuming that the obvious will be done. He would have to do that, because I am satisfied that the freight between here and Los Angeles would be too much of a handicap, and the local man would have that advantage over him. I did not say anything in my letter to him about building a plant 60 miles from San Francisco, but I said, assume fabrication within 60
4627 miles of San Francisco, and I have every reason to believe that he did. I do not know that Mr. Lacy did not give that part of the

matter any consideration at all. He did not inform me how much time he put on it, but he did tell me that he would have his best man work that up for me. I did not pay him anything for it. I cannot tell you how much time elapsed between my letter to him and the receipt of the information.

Referring to costs of fabrication: You have got a 30% shop overhead there, which includes your depreciation; then you have got 50% on the cost of labor and on that depreciation. I do not think you are justified in the assumption that the building would be entirely valueless at the end of the contract. These factories are 4628
all open on the sides, and all you would have to have would be the corrugated iron roof, and they are not very expensive. I do not know what the investment would be. I am allowing 30% shop overhead, which includes everything in his overhead, and takes care of his depreciation. I have not applied that in dollars and cents. I know that without knowing what the investment in the factory would have to be. It does not occur to me that that would be a very poor business venture for any pipe house; I happen to know that these figures are safe. 4629

The labor costs in column 5 of my Exhibit 100 is a unit expressed in pounds which my records justify me in assuming. My records are the results of conferences with men engaged in this line of business for the last ten years. I have had no experience myself. I have never owned a shop, and was not financially interested in one, but in talking with men and figuring with them, they said, you are dead safe on that as a basis. When all the men agreed on this line, both here and in Los Angeles, as to percentages, I am justified in taking it for my purpose. If these men with whom I talked had stated a figure one-half as much as this, I would not 4630
have taken the smaller figure, because I have seen the absolute cost of fabricating pipe in this city. There was a cost that was kept by Mr. Frank M. Hewson, of the fabrication of some 24 inch pipe in this city, which I think was built for a water company on the east side of the bay. This last week I have come into possession of the detail cost of fabricating about 10 miles or over of some 22 inch pipe for the Monterey Water Works. Before I made my appraisement I had a talk with Franklin K. Riffle, an engineer, and he gave me some costs. I did not use that in arriving at my appraisement. In arriving at this figure set down in Exhibit 100, I took into consideration my general knowledge of the cost of doing such work, gained from the men who are actually engaged in it. I went down 4631
to the Francis Smith shop several years ago and ascertained the cost of some steps in the making of pipe. Mr. Smith gave his foreman permission to tell me, because I was employed by him at that time on some work for the Watsonville Water & Light Co. I wanted to know those costs in case I ever landed in a strange country, so that

I could tell whether any combination of bidders were trying to put things over on me. If I knew that, all I needed to take was the going rates of wages. I am so positive of my stand on a lot of this work that I don't care what a lot of bidders will try to put up, for I know the business—I can tell them right off here is a combination.

4632 It is my business as appraising engineer to ascertain the cost of doing work, and I attempt to do so. I cannot tell you exactly what figures Francis Smith's men gave me as to labor costs. No particular man that I can tell you of told me that the cost of labor was 6/10ths of a cent a pound. I have had talks with various men, and that is the concensus of opinion that justifies me in making that assumption. I will tell you the name of one man who did not give me the information in confidence; Mr. Franklin Riffle did not ask me to regard the data that he gave me as confidential. I do not remember what he gave me exactly, but the result of all these in-

4633 terviews justifies me in that assumption. Mr. Riffle is an engineer who knows the details of pipe manufacture. I do not know definitely of his ever having manufactured any pipe, but from conferences I have had with him he told me enough to lead me to give great credit and weight to what he said. I do not recall that he ever told me that he ever had any association or relationship with any pipe manufacturing house. I do not recall that anybody else ever told me that he had any such relationship, but he knows the cost of fabricated pipe. He did not give me a definite 6/10th of a cent a pound of the shop labor costs, but he said I could safely assume such and such a figure. I asked what is the usual profit on this, and he told me; deduct one from the other and you get your cost. A lot of that information that I got from others was in con-

4634 fidence, and I am not relying on that in the appraisement which I am making here. I do not remember any man telling me definitely down to the exact cent what the shop labor costs were, but as a result of these investigations I am saying that that is the shop cost. These investigations were made during the past ten years. I have talked with foremen, and I have talked with the Lacy people who have had their foreman give me information and answer my questions. He gave me the costs of the various steps of the proceedings. He showed me all through the shop, the way they build their ma-

4635 terial, but I do not know as anyone gave me the exact figure for labor costs as .6 of a cent a pound. That .6 of a cent per pound was after they had their equipment complete, but there is a 30% overhead allowed. I gathered that figure from the talk that I have had with different men. I cannot pin it down and state any one man who gave it to me, nor any number of men who in the aggregate, or as an association or otherwise, gave it to me.

Various engineers, shop foremen, and contractors that I have talked with in the past ten years have contributed to my knowledge

on that subject; all of that talk has lead me to form that figure, and I know it is correct, because they have all gone around it. I went down to the Risdon Iron Works, and saw the operations performed on the pipe, and although they did not tell me what the labor costs were, they did not need to tell me, as I saw what the men were doing. When I looked at these operations I could tell these labor costs per pound of metal. I made various visits, and if you visit a place 4636
for several days and they turn out about the same, so much day in and day out, you have got a basis. I made memoranda in some of these cases. I can give you that as to the Risdon Iron Works. I remember I got the cost of calking and cleaning pipes with wire brushes.

SIXTY-SIXTH HEARING. NOVEMBER 23, 1915.

Witnesses: J. H. Dockweiler for Defendants.
Geo. L. Dillman for Defendants.

CROSS EXAMINATION BY MR. McCUTCHEN. 4637

I made no comparison between the Baker and Lacy prices, but I know the Baker prices fully bear out my assumptions. 4638

Questioned by Mr. Searls.

I imagine that they show whether they include the cost of dipping or not, as I asked for pipe double-riveted and double-dipped.

CROSS EXAMINATION BY MR. McCUTCHEN.

I made computations last night showing that the Baker prices are substantially in agreement with what my computations amount to. Using the Lacy quotations, and adding 20% to it for iron—the way he has indicated in his letter—Baker's price would be 24% higher than Lacy's on that one weight of iron.

Mr. McCutchen: This Baker letter says: "We are pleased to submit the following information on riveted sheet steel pipe as per your list submitted, the pound prices for riveted pipe made of bloom iron during the years 1912 and 1913 would run for the different gages about as follows". 4639

Mr. Dockweiler: He was quoting a price on iron, but if you read below, he shows a difference where he gives a quotation on steel. He calls there for bloom iron. Counsel here read the following from the same letter: "These prices would be f.o.b. cars Los Angeles; to arrive "at the price f.o.b. cars San Francisco, 27½ cents per hundred "weight would have to be added to those two figures. Your last two "items show as steel sheet pipe. This we take to mean regular Besse-

"mer product. The price on this would run about 3.7 cents per "pound f.o.b. Los Angeles. The same amount of freight would be "added to arrive at a price f.o.b. San Francisco".

Mr. Dockweiler: There is a difference of 1½ cents a pound in the two quotations. I assumed the Allan Wood iron here, to give my quotation on. Bloom iron is the product coming from several muck bars which, after they have been piled on each other are put through the rolls. I learned that from reading up on the process of manufacturing iron. I got the costs of calking and cleaning pipes with wire brushes at the Risdon Iron Shop in the year 1907, when I ob-
4640 served the amount of work the men did. I was there the greater part of the day, and from that inspection I am enabled to tell you what the cost of calking is, and what the cost of cleaning with wire brushes is. I will give you that: Cleaning pipes, Risdon Iron Works, January 10, 1907; 5 men using wire brushes and files, cleaning rust from outside of 30 inch Spring Valley pipe being made here, the inside of the pipe is cleaned with wire brushes, both inside and outside are wiped off with cloths. About 12 pipes per day of nine hours are thus cleaned; wages $2.25 per day. That is the only specific instance I have of cleaning. I have seen lots of calking done in this city and in Los Angeles.

Questioned by Master.

Chipping is cutting the plate. Chipping was the old method of doing by hand and cutting a bevel off the edge of the plate. The
4641 process is now done by machinery. A man calks at the junction of the round with a lengthwise seam where the round seams overlaps the lengthwise seam, the edge of both seams for about 5 inches each way from the junction.

CROSS EXAMINATION BY MR. MCCUTCHEN.

This is outside calking on a 30 inch pipe 24 feet long. There were 5 sheets, and he did that work in 11 minutes. You don't do inside calking on light metal work, because you are calking one plate against the other. It is only on comparatively heavy pipe work that you do inside calking, because if you work the plates from the inside, you are going to spring the outer one; so that the best shop practice does not do inside calking on comparatively light weight iron such as this ¼ inch. I think it would be bad construction to calk this from the inside. With a light plate you only calk on the outside, and with heavy plate it is all right to calk on the inside. I got this information at the Risdon Iron Works January 10, 1907. I don't know of any other engineer who tried to gather data of that kind, but I consider it necessary in my case to do so. I cannot prescribe a rule of action for other engineers.

4642 Lay it to the ground that I have had no experience, for the moment; I had read specifications, and wanted to know the actual shop

practice of the technique of building these pipes, so that if it ever came up to me to let a contract I could know under the conditions whether the contract price was a reasonable one or not. I did not necessarily feel deficient in that respect. I would go and see work tomorrow, as my idea is to accumulate as much information as I can. The more knowledge I have on the subject, the more secure is the basis upon which I am working. I think it is fundamental that the more knowledge an enginer has of the technique of this work the better off he is, because in the long run what is there about this fabrication that is mysterious? You simply take a sheet, and you roll it up, and you make it tight, so that it is a tube, and then you fit another tube on for the purpose of carrying the water. The cost of cleaning with wire brushes, and calking the pipe makes a big difference, because I want to know what each step costs if I possibly can. I want to 4643
give you some calking data: One man should do from eight to ten roundabout seams in eight hours on a 40 inch 5/16 steel pipe. This gives him a rate of ten to fourteen lineal feet per hour. If conditions are good, a man ought to do at the rate of 15.6 lineal feet per hour. This rate is done with three tools only; a fuller, a caulker, and a fine tool, which are operated by a gun worked by compressed air, which can be generated from electricity, or whatever your motive power is. I would operate an air compressor with electricity, which would require a good deal of equipment, but that is where your 30% comes in on figuring on your price. The small air compressor is a portable device, and you see them carried along the trench. The Risdon Iron Works had a stationary compressor, because they used air for a lot of work. These little tools are in the shape of a chisel 4644
or a drill, inserted into this air hammer, and you go over the plate with the different tools. Nowadays only one drill is used.

I have had an opportunity of comparing my figures on these elements of cost with someones else. For instance, on a 24 inch steel pipe, made in the shop of Montague in this city, in 1902, for the Contra Costa Water Co. This was given me by Mr. Hewson, who was in Montague's shop as an inspector at that time, and who took the cost record of making this pipe. I do not know by whom he was employed at that time, but I have faith in the reliability of this record, as I have great faith in Mr. Hewson, who was not a pipe manufacturer, but he observed and kept the record. I was not observing in this case the work of an observer. This is a record I have received, all of which is data which rounds out my knowledge. The caulking costs 22.1 cents for a sheet; this sheet weighs 275 pounds; I am taking it with the finished rivets in. You divide .22 of a cent by 4645
275 pounds, and it will give you the price per pound for caulking. To caulk one sheet weighing 275 pounds, this is a plate 5 feet long and sufficiently wide to make a 24 inch steel pipe, it costs 22.1 cents.

Here is a memorandum I got from the Francis Smith yard, March

24, 1910: Using a gun under 80 pounds air, first going over with a fuller, which is a rounded chisel, and then with a caulking tool, plates having been already sheared or beveled, one man can do a boiler 44 inches in diameter by 11½ feet long, 4 round seams and 5 long seams, in 3 hours. At that rate he does 21 2/3 feet per hour. A caulker gets 50 cents per hour. I was not making boilers, but a steam
4646 boiler works under pretty heavy pressure, and the object of caulking is to make a tight joint. It was not necessary for me to resort to boiler making to get my information, but I am just giving you an idea of the cost of caulking, whether it is on boilers or on pipes. It is caulking whether it is on a boiler or on a pipe. A caulker works 9 hours per day, wages $4, in 1907. In 1910 he works 9 hours, 50 cents an hour, wages $4.50. I do not know that there was that advance in wages from 1907 to 1910, but I presume there was. I am just giving you the rates of pay that appeared in these memoranda which I have here. That increase from $4 to $4.50 means 12½%. Using a pneumatic tool, he can safely caulk 5 lengths of 30 inch pipe in one day, and in some days he does 6. He caulks 5 round seams, and 6 lengthwise seams on each pipe which is about 24 feet long. 3/16ths inch chisel, 80 pounds of air, and a No. 3 pneumatic hammer. I didn't go into the size of the compressor that he has to generate the 80 pounds of air. The fruit of the pudding was that the compressor was furnishing the work. With an ordinary compressor you can put an entire field riveting outfit that is portable to take care of 3 or 4 riveter's tools; it does not cost you to exceed $2,500, and that includes the long
4647 lines of hose. It is a portable device, and a self-contained proposition, worked by an auxiliary engine.

The process of caulking: He first pores a little oil on edge of seam; then he takes a hammer and strikes along the seam lengthwise, 40 blows to bring the edge of the metal in contact, or to a seat. In using the chisel, which is beveled, he runs along the seam up and back with the point edge up; then he finishes with point edge down—he took 2 minutes for a lengthwise seam. I have not that down to a point where I could tell you the cost of each one of the 40 blows, but I am telling you the process, and it is very instructive. This caulker did the first pipe at the rate of 35 lineal feet of seams per hour, or 381.6 feet of seams in 9 hours, when he does 6 lengths of pipe. Caulkers were paid 50 cents an hour during 1913, but they only worked 8 hours a day.

4648 The length of time that these portable compressors costing $2500 will last depends upon the amount of work they are doing. The greatest waste on that is the hose, but relatively that is not a great expense. I never saw the manufacture of hose. The compressor hose looks like hose, and may be run around with little rings of steel to protect it on the outside. I have had hose supplying steam to a steam drill, and it is wound on the outside with bands of metal. I have

not given you all the basis that I had for my statement that the labor cost for the fabrication of pipe of this kind is .6 of a cent per pound. I cannot recall what data I have received in the past 10 years that 4649
enables me to say that the labor cost is .6, but you can set down Mr. Hewson's record as part of the data. All of these data I have given are corroborative of the figures I have set forth.

I examined the minutes of the water company as of the 15th of February, 1900, and there were three bids noted there, to my recollection. One was the bid of the Union Iron Works, the other of the Risdon Iron Works, and the third of the Schaw-Ingraham-Batcher Co. I took the bid of the Schaw-Ingraham-Batcher Co., and discarded the other two because the latter had the contract price awarded to them. I did not take that bid in estimating; it is merely data going to corroborate figures which I have given. I do not know how long those firms were in existence but I believe that the Risdon and the Union Iron Works were firms of very good standing. I did not take the Schaw-Ingraham-Bacher bid because I thought that bid corroborated my figures, as I did not make an estimate on that line to work it out; I think I gave you a computation of so much per pound of pipe, and I think I worked it out in pound price. I did not make any use 4650
of that whatever. The size of the pipe covered by that Schaw-Batcher bid is set forth on the exhibit as 44, 37 and 36. There is a difference in the cost of laying that pipe on top of the bank. A 37 inch costs 42.8 cents a lineal foot for laying, and it is the same for 36 inch pipe; the 44 inch pipe costs for riveting and laying it in the trench 49 cents per lineal foot, and the 44 inch, ¼ inch weighs 140 pounds, which would be .35 of a cent per pound. The length of the joints on the 44 inch is 20 feet, which information I obtained from Mr. 4651
Sharon, I think. It would cost 37 cents per lineal foot for coating the 37 inch pipe. It is 1 cent per inch of diameter per lineal foot, and that would include the cost of painting it in the trench as well. About .11 of a cent per pound would be a proper charge for cartage and freight on the outside. It would be about 2.20 a ton. I have that segregated, but I can't just place my finger on it. That is $2.20 a ton for the average, and it is for fabricated pipe, too. To get that 4652
$2.20 I made an estimate of it, and I have some figures some place, but I cannot place my hands on them now.

In the case of the Schaw-Batcher pipe, I presume that was a price on the pipe f.o.b. San Francisco, but I do not know whether it included any of the expense that would be incurred after the pipe left the foundry. I do not know just what the specifications call for on that job. I never saw their letter. I set it forth for what it was worth and it gave an idea of the work that was being done for the company. It was instructive in a way, for here comes in a new man and submits a bid. That was the first time as far as my investigation of the company's records have shown that the firm of Schaw-Ingraham-

Batcher Co. appears. So that is the reason that I drew the conclu-
4653 sion that a new man had come in and submitted a bid. I don't know what motive actuated them in getting the business.

A true copy of the letter addressed by the Schaw-Ingraham-Batcher Co. to the Spring Valley Water Co. was handed the witness, who stated the following from it: This letter sets forth that all pipe is to be chipped and caulked on all seams as well as laps, we to cut straps from plates furnished us, the same to be punched, scarfed, chipped and caulked when riveted in place. Also the following was read by witness: "We are also pleased to quote laying as follows: "44 inch straps joints at $20 per joint"; I do not remember whether that is $1 a foot or not. Some of the joints were 20 feet long, and some were 29, but I cannot make out from this whether this is the cost of doing extra work, because it says "$20 per joint"; that may be the extra work for that joint. I certainly am in doubt about what
4654 that means. On my direct examination I stated what the minutes showed the pipe had cost the company per foot, and I took it in the absence of any data that that was the cost of the pipe laid in the trench. My interpretation of that letter is that the $1.37½ covers the cost of laying that pipe in the trench, and riveting and caulking it in the trench, because he says here "we to cut straps from plates "furnished us". I am frank to say I cannot make out just exactly what was done in accordance with this letter. It does not state here whether they were to dip the pipe. Following the Spring Valley practice, I do not think that any bids received contemplated coating pipe, because the company always coated its own pipe. There is nothing here about coating.

4655 If it were to cost $20 a joint for laying this pipe, you would have $1 a foot to add to the $1.37, and for a 37 inch pipe the cost of coating would be 37 cents per lineal foot. I cannot tell you what the charge for bends would be, because my estimate is on straight pipe; all
4656 specials and bends are computed extra. I think I took the bends at so much per piece. I could not say whether 35 cents apiece on pipe of that size would be a reasonable allowance for that purpose. My allowance for cartage and freight on all the country pipe, right straight through, is $2.20 a ton. On your premises, if you take $1.375 for the 37 inch pipe, you would get to considerably over $3 for the pipe when laid in the trench and riveted and caulked. I don't assume that you are figuring on the same basis as I am as to that letter. The straps I have figured extra, and that price there is about fair for the straps, just as I figured it. The letter also says "We are also pleased "to quote you laying as follows": He evidently had strap joints. In order to lay the joint he had to have the piece of tubing in between, and although he does not say he will furnish that, I am calling your attention to that fact. I understand from this letter that they are to be furnished with the material.

Mr. Metcalf: I think that in the dipping of a 37 inch pipe it would be 37 cents per lineal foot. The pipe weighs about 100 pounds, which would make it about .4 of a cent per pound. 4658

Mr. Hazen: The 36 inch pipe referred to in this letter seems to be on page 129 of the schedule. I do not find the 44 and the 37 in any item that appears to be in the inventory in correspondence to these items.

The Master: The corrected figure would be $2.745, including the laying charge and dipping.

CROSS EXAMINATION BY MR. MCCUTCHEN.

I would not say that those figures are about 2½ times as much as mine. I had 37 quarter inch pipe that weighs 114 pounds, $6.24 a foot. That is $1.45 per pound dipped. The freight is $2.20 per ton, and that is .11 cents per pound. My note on the pipe laid is $6.68 a foot, without any trenching or backfilling. Divide $6.68 by 114 and 4659
it gives you 5.86 cents per pound. That makes $1.86 per foot. Taking $1.375 from that as the cost of fabricating in the shop, and that gives you .49. On that basis this figure has to carry the pipe to the trench, and to lay it, but that is not the way I computed it, because I do not assume that $1.375 a foot. Taking that 28 feet at $20 a joint, it would be 71 cents per foot. Now we have $1.375, and 71 cents. The coating is 37, and that makes $2.45. The freight and cartage makes $2.58 a foot. Taking Mr. Hazen's figure of 25 cents for cartage and 4660
freight, and adding it to $2.45, and you get a total of $2.70; then adding 3½ cents as a fair allowance for bends on that pipe—which is Mr. Hazen's figure also—and it would give you $2.73½ cents. Taking 35 cents instead of 3½ cents a foot, and the cartage at 25 cents, and adding it to 2.45, and you have $3.05 a foot; then taking out the $1.375, and you would have the joint, coating, bends and cartage, amounting to $1.68 per foot. The total per foot, including the $1.375 is $3.05½ as against my figure of $6.68, which includes metal. $2.12 would be my price, because the metal weighs 114 pounds to the foot, and at 4 cents a pound that would give $4.56 a foot, which subtracted from $6.68 leaves $2.12 a foot for my figure against your figure of $3.05; but remember you have included your bends in there, 4661
and I have got my bends separately estimated.

The letter of the Schaw-Ingraham-Batcher Co. was offered in evidence, and marked "Plaintiff's Exhibit 100g" Defendants

Referring to 44 inch pipe; the cost of fabricating per foot would 4663
be $1.65, and the quotation for laying 44 strap joints was $20. The angle joint at $25 we will take at $20, and divide it by the length, 29 feet, as shown on Defendants' Exhibit 100b. Dividing 20 by 29, 4664
it is about 69 cents a lineal foot. That is what we call fabrication; now that is laying. In the coating we use 44 cents. Freight and cartage $5 a ton on the weight, not including the coating. All of

my weights are undipped, and I used 38 cents a foot there. Using 42 cents for bends, that is $3.58 a lineal foot, and deducting from that the 42 cents, it is $3.16 a lineal foot, as compared with my figure of $2.35. My price on that at the side of the trench is $7.95. The metal weighs 140 pounds; at 4 cents that is $5.60, subtracting which from $7.95 gives me $2.35 a foot. As you figure it, the comparison on a pound basis would be $2.27 under the Schaw-Batcher bid, with the additions I have made to $1.68 on my figures, but there is not anything here to show that in their laying they would do the hauling. There is no suggestion that they would do any cartage and freight, but it is just as fair to assume that they will. From my general knowledge of the situation, I would say that you could not assume that they were going to do the dipping, but as they are taking this material from
4665 the shop, it would seem reasonable that they would include the cost of getting it on the job, as they are to do the laying; it does not seem quite the common sense point of view that you would have a man fabricate it, and then you pay the cost of transporting it in between, and then have him handle it again. I do not know any of the facts surrounding this contract at all, but I judge that the obligation to make delivery at the side of the trench would have arisen had the company accepted that bid to lay. As you view it, I am willing to admit that I don't find much support in that Schaw-Ingraham-Batcher contract, but as I view it, I think it is very instructive and supporting. Their cost of fabrication supports me—this was 15 years ago, and methods and improvements have made for the lowering of unit costs. This may have been a very small order at a relatively high cost, and in view of the uncertainties, I think it is very instructive as well as supporting.

I do not consider the figure set forth in the Schaw-Batcher letter a fair one for fabricating and laying. I allow a higher figure than that. They state here "We are pleased to quote you for the manufacture of the following pipe $1.65". The fabrication, taking that 140 pounds to the foot, is 1.18 cents a pound, and I tell you the 1.25 bears me out. The pipe weighs 140 pounds a foot, and it costs $1.65
4666 per foot. Now divide the $1.65 by 140 and you get 1.18 cents a pound. There are uncertainties surrounding what is contemplated by laying; there is no uncertainty as to the fabrication, and on the fabrication I do say that their figure of 1.18 cents a pound fully bears me out. I have been trying to ascertain the cost of making pipe for the past 11 years. I started in definitely sometime in 1913, but naturally I used all the information I had in the shape of data and recorded in the cells of memory.

4667 RE-DIRECT EXAMINATION BY MR. SEARLS.

I was asked yesterday as to the interval between my communications to Mr. Lacy; I wrote him on the 20th of February; he answered

me on March 5th, and I again wrote him on March 19th, and he replied on March 30th, but if you will note the correspondence, he says there was no time lost in the interval that he had his men making the computation, so the inference that it was one of these dashed off statements on figures, cannot be deduced from the statements set forth in the letters to me.

I will give you the results of my efforts to determine how Mr. Baker's figures compared with mine: Take for instance on 5/16 gage, Baker gives a quotation for a steel product at 3.07 cents a pound, and what he calls bloom iron for the same weight he gives 5.15 cents a pound. This is pipe fabricated, so he makes a difference of 1.45 cents per pound. Take steel at 2.50, the way I figure, and adding 1.45, it is 3.95, so that practically makes the basis that he differentiates between steel and iron. Baker's figures give a close check. Take on 4668
Exhibit 100b; I give for the 54 inch pipe $9.61 per foot dipped, whereas, this pipe weighs 181 pounds undipped. Baker's price dipped, with freight added from Los Angeles is 5.42 cents per pound. Multiplying 181 by 5.42 per pound gives you $9.81, which Baker's quotations would be, as against my estimate of $9.61 per foot. Take the 36 inch, ¼ iron, my price for this dipped is $6.08. Take Baker's price dipped, with freight added from Los Angeles, it is 5.42 cents a pound; multiplying that by 111 pounds, which is the weight per foot of that pipe, gives $5.96 per lineal foot, as against my figure of $6.08. I have not allowed freight on the dipping, but that would not make much change. My figure does not include laying. I am just comparing the Baker quotations. Now take the 22 inch, 3/16 gage; my price per foot dipped is $2.93 per lineal foot. Baker's price, with freight added from Los Angeles, 5.52 cents per pound. Multiplying that by the weight of the pipe gives $2.86 per lineal foot; Baker is $2.86, where I am $2.93 per lineal foot, and I am quite sure I am right now.

Questioned by Master. 4669

I have not included the freight on the dip, but he states the freight from Los Angeles is 27½ cents per hundred weight, and if the pipe was fabricated, they would not fabricate in Los Angeles and haul the material up here. They would fabricate around the bay, and save that local freight, but San Francisco is a terminal as well as Los Angeles, and the metal would cost delivered here just the same price. If I figured the freight on the dip, it would be 4 cents a lineal foot.

endants A copy of the Baker letter introduced and received, and marked 4671
"Plaintiff's Exhibit 100h".

I have checked up my figures on the Los Angeles waterworks, and I have found that I have similar figures obtained from Mr. Mulholland himself, and the figures exactly agree with the figures here submitted as to weights and prices. The record of the purchases of

riveted steel pipe by the Los Angeles City Water Department, which you have there in that table, were obtained from Mr. Mulholland. The table shows the purchases of quantities of pipe between the dates December 18, 1905, and November 2, 1910; the number of feet purchased, diameter, thickness of metal, the weight per lineal foot, and the price per foot are given; the cost per pound is computed by me. I divided the price per foot at which it was sold to the city by the weight as given, and this cost per pound includes the weight per lineal foot, and
4672 includes the asphalt dip. The cost per pound in the right-hand column includes the metal, the fabrication and the dipping. Defendants

The table was introduced, received, and marked "Plaintiff's Exhibit 100i".

I have a record of bids submitted to the City of San Diego, entitled "Schedule of bids on 24 inch pipe line from La Mesa to San Diego, October 28, 1914". This tabulation was obtained by me from Mr. H. A. Whitney, hydraulic engineer, San Diego, who was hydraulic engineer for the city at that time. Mr. Whitney informed me that this was a correct copy of the compilation of the bids received on that work. I have the specifications on which these bids were submitted.

4673 Questioned by Mr. Greene.

My figures were not based on this. This is October, 1914, and I had made my figures before these bids were ever submitted.

Questioned by Mr. McCutchen.

I would not want to state that prices were very low in October, 1914. Steel may have been low, but it gives you a fair idea of the cost of fabrication and transportation, etc.

RE-DIRECT EXAMINATION BY MR. SEARLS.

4675 The cost of making steel pipe, wages, and the cost of fabrication, have not dropped since the commencement of the European War.

Questioned by Master.

Fabricated steel follows along the cost of steel itself, which has been very low. The fabrication cost is about the same. This Sacramento steel was laid down in San Francisco at 1¾ cents per pound. The finished plate follows the cost of steel itself. That is, a pipe manufacturer will adjust his weight according to the price which he has to pay for the metal landed here, and the variation would depend solely upon the cost of the metal itself.

Mr. Dillman: The price of steel went down, not as the result of the European War, but from the opening of the Panama Canal. It
4676 has gone up, and is quite a little higher today than it was in 1913. Manufacturers are not willing to fabricate at a less cost than they were in 1913. There is a bigger demand for their steel today, and they get more for it. Steel has gone up over 50% in the last two years. I have not kept close track of the steel market, and cannot say whether it fell in the East after the outbreak of the European

War. I do not know that the opening of the Panama Canal did affect the eastern market as to steel, and I do not know whether steel fell in the eastern market following the outbreak of the war. I do not think there was much difference in the price of steel between the 4677
years of 1914 and 1913; there were fluctuations in 1914. My information does not refer to the eastern market. What I keep track of is the western market here. I do not say that the cost of steel fell, but that the cost of the finished product did not fall in proportion. I do not know that I can go into the details of the causes of the fall in the price of steel, but I consider the principal cause for the dropping in steel in 1913 and 1914 in this market was the opening, or the threatened opening of the Panama Canal. I do not know that thousands of operators in the eastern mills were discharged following the end of 4678
1913. I know that many of our mechanics were taken East to work on steel manufacture in 1914. The fluctuations now are very much higher than they were in 1913 or 1914. I consider the price of steel was higher in May, 1915, than it was at any time during 1913. 4679
This is from memory.

RE-DIRECT EXAMINATION BY MR. SEARLS.

I have some data prepared and arranged in tabular form which were received from Mr. Arthur L. Adams as to Contra Costa costs. Mr. Adams was Chief Engineer of the Peoples Water Co., and prepared the specifications for the work relative to which I have the tabulated data.

Questioned by Master.

I do not follow Mr. Adams' pipe cost in all cases; this is merely data which I had in my office files, and it is an aid in forming my unit prices. Whether I had this particular work in mind at that time, 4680
I do not want to state.

Questioned by Mr. McCutchen.

This is offered as supporting data, but whether I had it before me or not at the time I made my appraisal, I know at the time I was fixing these unit prices that I reviewed considerable of the data that I had; I do not want to be understood as saying that I positively used this.

Questioned by Master.

I cannot state that I gave special weight to this or to that. It is one of the tools, I might say, that I employed. I did not pin my ap- 4681
praisal on to this one, or on any specific job.

Questioned by Mr. McCutchen.

These figures of Mr. Adams' are comparable to my estimates on laying pipe, on hauling and distributing pipe, and also on backfilling. The total of my item on laying pipe is 23 cents a lineal foot, or .46 cents per pound, which is for labor only. Then there is the hauling and the distributing of the pipe, which was 6 cents a lineal

foot, or .12 of a cent. My schedule shows the cost of laying pipe under my idea of profit. In arriving at my unit price, I had to take a figure that represented the labor, and in my cost of laying pipe, I have my profit in, on my laying. These figures were considered by me in
4682 connection with all the data I have gathered. The figures in Mr. Adams' schedule are reasonable. While I did not have the cost at that time, I remember that job when it was being performed, and I was out on the work, but I kept no cost record of the entire work, but relied upon this data as to the cost of that work.

The table was introduced, received, and marked "Plaintiff's Exhibit 100j".

Questioned by Mr. Greene.

I got those figures from Mr. Adams, and arranged them. These sub-heads are the ones I put in myself. I am informed that these figures are a copy of the prices of the total cost of that work.

Questioned by Mr. McCutchen.

Mr. Adams did not prepare this statement just as it is. The costs are arranged by me.

4683 RE-DIRECT EXAMINATION BY MR. SEARLS.

I put in the totals, and classified the items, and I also put in the 8 hour work day. That does not appear in Mr. Adams' statement, but I know that it was done on an 8 hour day, as I was on the work myself, though not every day.

Questioned by Master.

The total cost, and the cost per lineal foot are Mr. Adams'. The items appearing opposite "total cost" and "cost per lineal foot" are those of Mr. Adams, but the arrangement, the subdivision, and the deductions, are my own.

Questioned by Mr. Searls.

By deductions, I mean that he did not state how much per cubic yard, or per foot.

Questioned by Mr. McCutchen.

I asked Mr. Adams to furnish me with this information. He gave it to me in writing, and I have it over in the office. I do not recollect whether Mr. Adams testified in the case now under submission to his Honor about the cost of this pipe line. This is not
4684 part of the Oakland Division.

The sheet was retired for the present, and not marked "Plaintiff's Exhibit 100j".

Mr. Hazen: I will tell you where those three pieces of pipe are that we could not locate this morning, the 44 inch, the 37 inch, and
4685 the 37½ inch are on page 331 of the inventory. They form part of the line from University Mound to the City, and replace light lengths of pipe in the original line. The line crosses two valleys, and owing to errosion the valleys filled up, so that the old pipe was

covered to a depth of 20 feet or so, and it was thought best at that time to replace it with a new pipe at a higher level, so these two pieces were brought and put over the valley at this different level, and the old pipe was discarded. The 36 inch pipe was built going from Niles Screen House to connect with the Alameda Aqueduct, to its then terminus. The Alameda pipe first went from Niles Dam before the Sunol Dam was built; at this time the Sunol Aqueduct was completed, and about a mile of 36 inch pipe was laid to connect the new intake with the old pipe. The 36 inch was a little over a mile long, and the 37 and 44 were comparatively short pieces.

RE-DIRECT EXAMINATION BY MR. SEARLS.

Generally speaking, they would charge you a little bit more for a short piece of pipe than for a considerable amount of it.

Questioned by Mr. McCutchen.

All of Mr. Mulholland's pipes are fabricated under specifications. I do not know positively as to that, but I have copies of some specifications covering some of those pipes. I cannot offhand tell you whether these specifications call for inspection. 4686

Witness: Geo. L. Dillman for Defendants. Dillman

CROSS EXAMINATION BY MR. MCCUTCHEN.

Referring to the pipe laid for the Contra Costa Water Co. from the glue works. I surveyed the line, and made a profile, and reported to the company the minimum thickness of pipe, and the size of the pipe that would be necessary to carry that water. A few days later I was given a copy of a contract with the Risdon Iron Works, and was told to go ahead and do the work. I let the other contract for hauling, excavation and backfilling, and supervised the execution of the work from the beginning to completeness. The trenching and backfilling was done by George Emmons, and it was sub-let to James Stanley. The hauling I do not remember. The fabrication of the pipe, and putting it together in the trench, was done by the Risdon Iron Works. The size of the pipe was, I judge, 18 inches. It was not less than 16. It was nearly all of it laid in a trench, and was not very good work, although sufficient for the purpose. It was not as permanent work as the Spring Valley work. It leaked, but not very badly. It leaked because it was fairly thin pipe, and the joints were not tight, nor was the work specially well done. If I were manager of a waterworks, I should prefer to do 4687
better work. The Contra Costa was hard up, and wanted a temporary line, and did not want to pay any more than it had to to get it. The pipe was made of steel, and was bought as a complete pipe. I do not know what the fabrication cost. The longitudinal seams

were double riveted; they were rather light, and not especially well spaced. The efficiency of the joint was sufficient for the purpose; it did not burst.

I think probably the excavation in my Stanislaus work was a little cheaper than would be required on the Spring Valley system, though there were portions that were more expensive than the average of the Spring Valley excavations. Nearly all of it was done by a trenching machine, and part of it was through deep trenching where they ran into gravel and sand that caved in on them badly, and there was a good deal of hand work there. I do not think they lost money on the contract. They were satisfied when they got
4688 through. That work was done in 1912.

I got no written quotations on riveted pipe to use for the purpose of making my appraisal. I do not keep track of the market prices. I have not paid very much attention to quotations, as I do not regard them as of very great value. Most of the riveted pipe that I have had anything to do with was sold by the lineal foot. I have bought it by the lineal foot from Francis Smith, the Hendy people, and the Risdon Iron Works. I think the Risdon price was a stated number of feet for a lump sum, the thickness and size of the pipe being given. That pipe was bought, so many feet of pipe, for so much money, and that was under a contract, according to my
4689 recollection. Pipe is generally quoted by the lineal foot. I am talking of manufactured pipe on this Coast, which is the only place I have had any experience with riveted pipe in construction. I am unacquainted with the practice of the steel mills of the East.

I stated the other day that my impression was that all steel products in quantity were sold by the long ton. I do not know but what sheet wrought iron is an exception to that rule. I have assumed in my practice that it is so with steel products, but I have never bought any. The principal product that I know of that is sold by the long ton is steel rails for railroads. I do not know whether a man making a contract for 100 tons of steel plates would get long tons or short tons. I was more positive the other day that the long ton would obtain than I am now. It would make 12% difference in the cost of pipe if it were bought by the ton. I did not assume that it would be bought by the ton when I made my price for this pipe laid. If the 12% was there, it would increase the contractor's profit to that extent, because he could buy 2,240 pounds for a price that
4690 he would otherwise have to pay for 2,000 pounds. I did not assume that he would get 2,240 pounds in making my figures. The pipe in my table, which was put in evidence the other day, will show you as near as I can how I reached the price per lineal foot. I could not segregate those costs. I know more about the finished cost than I do about many of the details. I knew that this was wrought iron pipe before I was advised of it here. I believed, and one of my

assumptions was that the material in wrought iron could not be obtained for replacing today, but my price is sufficiently above a price for steel to cover what I thought would be the cost of wrought iron. If I am wrong in that, and if Mr. Hazen's statement that there is only one mill available for rolling this wrought iron, is right, and the specification was for wrought iron, it is possible that my price may be too low, by reason of the monopolistic position of the mill. 4691

Mr. Hazen: I did not say there is only one mill in the United States that would produce wrought iron. I think there is only one mill in the United States rolling plates ¼ of an inch in thickness, but there are many mills in the United States making plates. There certainly are others that could do that, but they are not doing it at the present time; they are using it for commercial purposes.

CROSS EXAMINATION BY MR. MCCUTCHEN.

Wrought iron plates are a commercial product, and the various methods of manipulation I am not entirely familiar with. I have never read the specifications under which these plates were rolled for Mr. Schussler. I assume this pipe was riveted pipe, and the prices that I know about were prices for steel pipe. There is some 4692
addition to those figures to cover the added cost of wrought iron. Pipe steel today is a material that is very good, and my information is that it is almost as good as wrought iron; that is a matter of hearsay. I accepted it, and my price, therefore, is for steel, with some addition for the extra cost of iron, if the steel is not considered as good as iron. Taking it for the purpose for which it is to be used, I should prefer wrought iron, because it is more malleable, works easier, and caulks better. Wrought iron has more lasting qualities after the coating is destroyed, which makes it preferable to steel. It rusts slower. The durability of a pipe is not all a matter of coating, but it is principally a matter of coating. There are a great many kinds of wrought iron, but the standard of wrought iron that I have had quotations on—not recently—and that I thought of using, was known as the Allan Wood iron. That is the standard of wrought iron in my experience. There would ordin- 4693
arily be laminations in the plate, produced by rolling, cutting, laying together, heating, and re-rolling. I think that all adds to the serviceability of the pipe or the plate.

I have no faith in the inspection of steel in Eastern mills at all. I have never had any wrought iron manufacture inspected. On a job as large as the one I am figuring on here, it is very proper to have them inspected, and I would inspect them somewhere. If there was only one mill that rolled them, and they did not allow inspection, I would not go to the mill to inspect them. The in- 4694
spection would add very little to the cost of the product. There are

inspections that might add considerable, such as inspections by men who had authority to pick out flaws that were insignificant, and to discard sheets that were perfectly good but did not suit their fancy, and otherwise disturb the operation of the mill affairs. I do not attribute the durability of the Spring Valley pipes as compared with steel pipes, entirely to the coating, as I consider that wrought iron will last better than steel pipe with the same coating. I am not prepared to say that if steel pipe had been used in the Spring Valley system, and they had been coated just as the iron pipes are coated, that they would not have pitted and tuberculated where the iron pipes have not. It might be so, and it might be a great deal worse in one part of the iron than in another. The principal element in the life of a pipe of this kind is in the coating. I am not prepared to say that wrought iron pipe is worth this extra cost today, nor am I prepared to say that it is not. The ultimate fact could only be
4695 determined at the time that the pipe had so far deteriorated as to warrant their renewal. I have not ascertained how far the deterioration has progressed in this system, but I have inspected some pieces of pipe that were taken up down in San Bruno, and of pipes in the yards at Millbrae.

The quotations I have had on Allan Wood iron in times past have usually added about 25% to the cost of the steel for wrought iron. I have never made any wrought iron riveted pipes. If I were making a contract for the laying of pipe, I should require that it should be done under inspection, and would regard it as bad practice not to require inspection. I do not consider that it would cost any more
4696 to have a pipe made under inspection than if it were not inspected, provided that the contract was reasonable, and the contractor straight. Those are elements that you must take into consideration in practical construction of all kinds, and the contractor takes them into consideration when he is bidding upon work that is to be done under inspection. He does not necessarily add for it, but in many cases he does add, and in large sums. I do not know of any pipe that has cost more by reason of this inspection; it is in other work that I can specify very definitely.

In making an estimate of this kind, one has to assume certain specifications; in my assumptions, the specifications were not onerous. The inspection was not finicky, but in each case reasonable; it is from that standpoint that my figures are made. If I were asking a man for a quotation on pipe without telling him how it was to be made, I would expect to get shop practice from him, and if I were careless enough to allow it, that might result in giving me under-
4697 riveted pipe. To prevent it I would specify what might be called fully riveted pipe, instead of under-riveted. I might not do that when I was asking for a quotation; it would depend on the man, and if he were a careful man, he would ask how the pipe was to be

riveted, and what sort of inspection was to obtain. In some cases I would take any man's agreement to deliver me pipe, riveted in accordance with his shop practice, and without any specification from me as to how the riveting was to be done, and if I knew what his shop practice was, I might in most cases. I consider many manufacturers would do a good job of riveting without special inspection and specifications. I should expect that very frequently pipe not manufactured under specifications is under-riveted. I did not use the boilermakers' standard in determining the manner in which pipe should be riveted, but it is a very good standard, and probably the best. Different boilermakers have entirely different standards, 4698
which are perfectly proper for entirely different jobs; some of the boilers are made like riveted pipe; others are much more carefully made; some are doubly riveted, and some triple-riveted; there is a great difference according to the maker, the requirements, the pressure, the duty, and whether it is for land or for marine practice.

I have not figured on the riveting of any of the Spring Valley pipe lines as to strength, as compared with the strength of the plate. From very definite information, and full belief, I consider an independent inspection of steel in the Eastern mills to be absolutely farcical. I have never come in contact with the inspection of wrought iron in Eastern mills, and I would not take it for granted that the inspection would be onerous, or disallowed; if the inspec- 4699
tion were reasonable and allowed, there would be no trouble with an independent inspection, and I would like to have it if I could. There is an inspection of the steel pipe made by the mill, and any independent inspector working for a company getting steel products is entitled to see those tests made; he has access to the records of past tests, and in that way the buyer gets an independent report of a mill's inspection. That is very satisfactory ordinarily, and sufficient for many purposes. I have stated that I thought the cost of fabricating wrought iron plates into pipe would be somewhat less than the cost of fabricating steel, on impressions gotten from talking with various pipe manufacturers in the past—Francis Smith, Montague, Risdon Iron Works, Schaw-Batcher. I cannot say that anyone of them have definitely stated how much cheaper it would be, but my general belief is that it would be nicer to work than steel. 4700
I have never manufactured pipe myself, and have never had steel pipe and iron pipe manufactured so as to enable me to make a comparison of the cost of fabrication.

Taking the 44 quarter inch, Mr. Hazen's weight is 141, Mr. Dockweiler's 140, and mine 125; that looks like a good deal of discrepancy on its face, but I think that the higher weight gotten by Mr. Dockweiler and Mr. Hazen is due to what is known as the Hazen formula, while my low weight is taken from the chart that was put in evidence here the other day—made some 20 years

ago from definite data as to the weight of material in pipes gotten from various manufacturers. I believe it to be fairly correct. It is
4701 something I have used for a great many years in making estimates and determining the thicknesses of pipes for certain purposes, and it agrees with the practice then, and I do not believe the practice has changed sufficiently to warrant my changing that. The Hazen formula is not a formula to be blindly followed. It is an empirical formula, and may be adopted by Mr. Hazen, and in the schools, and by the manufacturers, and still be wrong. In the matter of thin pipes, I think the Hazen is wrong, and contrary to the fact. My formula takes the gage of the metal without extras, and without coating, while Mr. Hazen's formula gets a nominal weight, which includes all the extras, and a coating besides. I therefore believe that the Hazen formula is not right for this case.

My chart is made up from weights of pipe as actually manufactured by manufacturers who gave me the data at the time. It was platted in the shape of a chart, so that it could be used for a great many different sizes and thicknesses of pipe. I have not the
4702 data from which it was made. It was made in 1893 by myself and another. I remember we got the data from pipe manufacturers to make that chart. It has been a very convenient chart, and I have used it without ever having it questioned for some odd 20 years. The schedule showing what the weight of the pipe would be so far as it affects this case is in that table that I have given. You would require nothing but the thickness and the size of the pipe to determine its weight by the use of my chart, and I think it assumes that the pipe would be of a uniform thickness throughout. I consider that a chart of that kind, made from actual data from pipe manufacturers, is of much more value, and nearer correct than the data gotten from an empirical formula, which on its face is consid-
4703 erably wrong. This is my chart, and if it is wrong, I still believe it is nearer the truth than Mr. Hazen's formula.

4704 It would be perfectly possible that the Spring Valley pipes will not measure in weight with this chart, but that is my method of getting at the weight, and I believe it to be a more correct method than the Hazen formula. I could tell approximately what the weight of pipe of certain dimensions was, if I did not have the manufacturer to depend upon, but I would rather have the facts from the manufacturer than to take my figures for it.

4705 The lap most decidedly makes some difference in the weight, and my charts include the laps and the rivets; it is the manufactured
4706 pipe. The weight of the pipe in this system I determined by the use of my chart upon the assumption that the lap here was the same as the lap in the pipes whose weights have been given to me. If my weights are wrong, that is the basis for them, and to the extent they are wrong, my estimate is wrong, but I still insist that my method

of getting at these weights is preferable to the Hazen formula, because the Hazen formula on its face is wrong. The Hazen formula, worked down for thin pipes—by thin pipes I mean working them down to zero thickness—is the test of this formula. That demonstrates, in my opinion, that it is less reliable than my figures. If I had known of the Hazen formula, and had tested it, and had accepted it, which I might have done in practice, I presume that I would have used the Hazen formula on this valuation, as empirical formulas are not always unreliable. 4707

Questioned by Master.

An empirical formula is a formula made to fit a large number of known facts, without being deduced directly.

CROSS EXAMINATION BY MR. MCCUTCHEN.

The Hazen formula does not happen to hit the bunch of known facts that I have in my possession, but I have used lots of empirical formulas, some of very doubtful value, too, as does every engineer.

Referring to the 44 by ¼ pipe, on which you have an actual weight which agrees with Mr. Hazen's weight, and which does not agree with the weight to be found by the use of my chart; if the rest of the pipe weighed according to that, I would say that Mr. Hazen's was right. I never had that fact in my possession in making this estimate. I was furnished no weights of this pipe, but was furnished with the thickness and diameter, and I supposed this was an agreed schedule. I see it is not quite agreed in some particulars, and to the extent that my figures disagree with the actual facts, I am wrong. To the extent that Mr. Hazen and Mr. Dockweiler disagree as to the actual facts, which are not known, we are approximately as close as we know how, with very few actual facts known exactly. I would want to investigate the Hazen formula much more thoroughly than I have to accept it. It is apparently wrong on its face. The formula is thickness in inches multiplied by diameter of pipe in inches, multiplied by 12½. To this product is added 10 pounds. That may be approximate in a great many pipes, but in the final test of that formula, when you run it down to a thin pipe, and make that pipe of a thickness of zero, you have, without any metal at all, 10 pounds as the weight of the pipe, which is the weight of the total. When you reduce the diameter of the pipe also to zero, you would have no pipe at all, but you would still have 10 pounds of weight for that pipe, when you have a pipe that has no thickness, no diameter, and no possible coating. Therefore the formula is wrong in form. At the same time, it may approximate some of these pipes; I have not tested it to the extent necessary to know what it does. 4708 4709

Mr. Hazen: That 10 pounds represents something. It grows out of the fact that the diameter of the pipe is measured on the

inside. Theoretically a better basis for the calculation would be the diameter halfway from the inside of the middle of the shell; that is, the center of gravity of the metal would be a better starting point, due to the fact that the seams and riveting are somewhat constant in larger pipes than small pipes, and for that reason, the formula with a 12½ d. T plus 10 approximates the weight of pipes of various sizes and thicknesses more exactly than would be the case if the 10 was left off, and the 12½ was increased. It is an approximate formula, and it applies, as we have found, pretty closely to large pipes. As I said, it does not apply exactly to small pipes, or thin pipes. Mr. Dillman is absolutely correct in his deductions when it is carried to an extreme; as a matter of fact, we did not use it in this case. We took the Lawrence weights of the undipped pipe at Millbrae, and modified it; in other words, we made
4710 a new formula from the actual Millbrae weights of undipped pipe, and we used those. There is this difference to be borne in mind in comparing my figures with Mr. Lawrence; I added 1% for the miscellaneous structures along the line not shown by weighing the straight pipe, and then I added 3% for the loss in waste in manufacture, because I wanted to get the metal that it was necessary to buy, rather than the weight of the pipe in the line, so my figures are larger than Mr. Lawrence's to that extent. With this modification, the formula is as I have just stated it; we did not use it for these pipes, and Mr. Dillman is perfectly right; it is not directly applicable to these small pipes. Mr. Lawrence deduced his formula for all of the small pipes, and then I modified it a little in mine, according as the plates were bought by gage or weight. I estimated more where they were bought by gage, and less where they were bought by weight.

Mr. Dillman: Had I had a statement of the weight of these different pipes, I would have been very glad to have used it, and had Mr. Hazen and I been allowed to get together a little while, I think it is one of those points we could have agreed on.

Mr. Hazen: I added 3% for the wastage in making the pipe, and I multiplied the total weight which I thus got with my 3%, by the cost of fabricating. The wasted metal did not reach the final
4711 process of fabrication, and if it were eliminated, it would make a difference of 3% in my total fabricated cost. The whole of the metal begins to be fabricated, and the 3% is eliminated in the process of manufacture. With several thousand of tons of pipe it would amount to a little. I think if we were to introduce that refinement at the end, it would involve a corresponding refinement in all of the underlying data; there would be corresponding changes in maps, so I do not think it would make any difference in the final result.

Questioned by Mr. Greene.

Mr. Hazen: Riveting would come in in the midst of the manufacture, and it would be impossible to tell at what point in my fabrication of cost it ought to be eliminated. I think 3% gives the waste of manufacture as the 97% that goes into the pipe.

Questioned by Mr. Searls.

Mr. Hazen: There is an amount of metal that comes from trimming; there is an amount that is punched out for rivets, and where some is cut off where a bend is to be made; there are pieces that are cut off for man-holes and saddles, and all the wastes there are 4712
in the process of manufacture go to make up the 3%. These wastes occur during the process of fabrication. The manufacturers have so much scrap steel or iron in the shops that could be recast and used again, but it has very little salvage value.

Questioned by Mr. Greene.

Mr. Hazen: Most of this waste would be in the shop. It is true it could be used for whatever it is worth.

Questioned by Mr. Searls.

Mr. Hazen: The 3% on 21,000 tons would be 630 tons. I do not know whether scrap could be sold for $5 a ton or not. I should say that the 630 tons could not be sold for $4,000 or $5,000.

RE-DIRECT EXAMINATION BY MR. SEARLS.

The strength of the joint is never equal to the strength of the pipe.

Mr. Hazen: The testimony that I gave was that the strength 4713
of the rivets is equal to the strength of the plate between the rivets. That is the plate that goes between the rivet holes.

Mr. Dillman: A fully riveted pipe is a pipe so riveted that when the pipe is put under pressure to destruction, the rivets will shear at the same time the metal between them pulls apart, but that joint is still much weaker than the plate itself. That would be the case with any pipe if it was well riveted. I think the most of the Spring Valley pipes are as well made as any riveted pipes I know of. At times the pipes made by the best factories are as well riveted as the Spring Valley pipes as far as strength goes, but not always. In my assumptions as to the specifications upon which the pipe would be reproduced, I assumed that the riveting was sufficient to make a tight pipe, and to allow the caulking to tighten up the seams. I assumed in the case of the Spring Valley pipe that the strength of the rivets was equal to the strength of the metal at the edge of the plate where the metal was cut away. The inside caulking is of much 4714
more importance than the outside caulking. If the caulking on the inside makes the pipe tight, the outside caulking is of no use to develop the maximum strength of that pipe; if it depends for tightness on the outside caulking, you have only a thin lip of metal to

caulk with, and for that reason, I consider that the inside caulking is of much more importance than the outside. I consider that the pipe will be caulked from the inside in making my appraisal, and I would not care whether it was caulked outside or not if it were sufficiently caulked inside.

If the Spring Valley pipe system were to be reproduced in 1913 with the best quality of steel then known, it would, in my opinion, be almost as durable as wrought iron, if not entirely so, giving them both the same character of coating.

Mr. Hazen: The pipes which I inspected with Mr. Metcalf, and walked through, is South San Francisco, and I have seen a good
4715 many others that have been taken up, but that is the only one that I have seen immediately after it was taken up before it got dried.

Mr. Dillman: I saw these pipes during the appraisal, and that was a part of my familiarity with the character of the pipes which I was going to value the reproduction of.

SIXTY-SEVENTH HEARING. NOVEMBER 24, 1915.

Witnesses: J. H. Dockweiler for Defendants.
Geo. L. Dillman for Defendants.
C. I. Rhodes for Defendants.
Allen Hazen for Plaintiff.

4719 Mr. Dillman: I find that in the early part of 1913 the price of steel was about as high as it is now, 2.35 cents per pound at Pittsburg. In 1913 it went down to 1.89. In October, 1914, it was 1.94. The lowest point in 1914 was in July when it went to 1.80. In April, 1915, it was 1.85 and 1.90. The low market in 1913 was the same as
4720 the low market in 1915; the low market in 1914 was a little below that. These quotations are for steel sheets f. o. b. Pittsburg.

Mr. Metcalf: That cannot be on tank plates. The average figures run about 1½ cents. In 1914 they were substantially below that on tank plates. Tank plates and steel sheets probably fluctuate together. In order to make a comparison with our work it would be necessary for Mr. Dillman to carry it back to the average figures. I think you would probably find the two groups would be closely parallel.

Mr. Dillman: I asked a man this morning who is up on steel, and he told me that Allan Wood iron plates could be delivered today in San Francisco at 3½ cents per pound.

4721 Mr. Hazen: It ought to be understood that nine-tenths of the Allan Wood iron and steel companies are making steel plates, and that steel plates made by the Allan Wood Company are ordinarily sold in the trade as Allan Wood plates. A reference to Allan Wood

plates does not mean anything without a very specific description of the quality.

The Master: These figures are submitted to show that at the times at which these bids were offered, namely, April, 1915, and October, 1914, it was not so low as to be comparable at all.

Mr. Searls: That is the idea.

Mr. Metcalf: This is a table on which Mr. Hazen's figures were based, and from which he determined the average price prevailing during the year. This gives the monthly price. The average manu- 4722
facturing price upon tank plates at Pittsburg, as quoted in "Iron Age", for the entire year 1914, was 1.14 cents as compared with the average of 1.48 cents for the entire period of years cited. The average price in October was 1.15 as compared with 1.14 for the year, and as compared with 1.48 for the entire series of years. The October price was approximately 77% of the average price during the series of years cited. In September it was 1.20 as against 1.14; in November it was 1.07 as against 1.14. The fluctuations during the different months of the year being from the low point in December 1.05 to the high point 1.20 in January, February and September; the average for the year being 1.14.

Mr. Dillman: The quotations I have are for steel sheets, which is the steel from which this pipe would be made, or from which steel pipe would be made. The difference between steel sheets and tank plates, is that a tank plate is ordinarily heavier. I don't know any difference between a sheet and a plate.

Mr. Hazen: The sheets of small pieces of steel that are made for roofing and for tinning, and that sort of thing, are manufactured in a different way from tank plates, and in the trade there is a distinc- 4723
tion between a plate and a sheet; it is primarily one of size, but it is manufactured in a different way, and there are different quotations between them.

Mr. Metcalf: Mr. Dillman's quotations are higher all the way through in the figures he has cited than tank plate quotations.

Mr. Dillman: The prices for 1914 were lower than they were for 1913 on the average. In 1913 they ran from 2.35 to about 1.90; 4724
they averaged about 1.90 for 1914.

Mr. Metcalf: That is about 81%; ours indicate 77%. The essential difference is that Mr. Dillman says that in the month of October, 1914, the figures run from 1.95 to 1.80.

Mr. Dillman: They were 5 cents above the average for the year, and it was the same for February, March and October, and very nearly the same for November. They are a little lower than 1913. I will guess that the mean of the manufactured readings would be somewhere between about 2.15 and 2.20 for 1913.

The Master: I will take the chart which is prepared by Mr. 4725
Metcalf, and introduced as "Exhibit 98h" as correct, until it is proven

incorrect. The question is whether contractor bids in October, 1914, and April, 1915, can be compared at all with the period that is concerned in these suits. I am willing to take that for what it is worth. I will receive the evidence.

Dockweiler Witness: J. H. DOCKWEILER for Defendants.

4726-4727 RE-DIRECT EXAMINATION BY MR. SEARLS.

Ten sheets showing the unit costs of laying slip joints, and riveted joint pipe in the country, and in the city systems, introduced and marked "Defendant's Exhibit 100j".

The sheet which you have contains the original figures furnished me by Mr. Adams on that Contra Costa job; the pencil memoranda are made by myself, and the typed portion is that which I received from Mr. Adams. In computing the pound basis I made the computations on the same method and by the same method as I have determined the weights here for this case.

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Dillman Witness: GEO. L. DILLMAN for Defendants.

4729 That is my inventory and appraisal of the structural properties outside of the City and County of San Francisco.

4730 This inventory was introduced and marked "Defendant's Exhibit 101".

I have obtained some figures on the cost of pipe work in the Oakdale Irrigation District. The work that has been done under these figures was commenced this year, and some of it is not completed yet. I obtained these figures of the Purchasing Agent of the Oakdale Irrigation District. It is prices for pipe delivered, and laid in the ground; the trenching and backfilling paid for under a separate contract. They were contracts made by the Oakdale Irrigation District this year, under different dates, for the installation of this pipe.

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Questioned by Mr. McCutchen.

I do not know what the specifications were. The 34 inch pipe is a gravity line, and some of the other pipes probably have a 20 foot head on them. These pipes are to be used for a purpose about equal to the Pleasanton pipe in its duties. I do not think any inspection was made of the pipe other than the inspection in the field. I should like to say something on the subject of under-riveting pipe: When a pipe is riveted sufficiently for the purpose for which it is intended, any additional expense of riveting adds nothing to the value of that pipe for the purpose. Therefore, any pipe that is riveted beyond a certain amount can be considered over-riveted pipe. Very probably this pipe would be under-riveted for higher pressures. I do not know

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that this pipe was riveted as the Pleasanton pipe was. I do not know the contract date under which that pipe was bought, except that it was this year. 4734

Witness: C. I. RHODES for Defendants. 4737

DIRECT EXAMINATION BY MR. SEARLS. Rhodes

I reside in Berkeley, and am a civil engineer. During the years 1905 to 1907 I was Assistant Engineer with the Monterey County Waterworks. I am a graduate of the University of California, from the College of Mining. While employed by the Monterey Water Co., I had occasion to act as inspector on a contract for riveted steel pipe, built by W. W. Montague & Co., of San Francisco. We were actually engaged in the manufacture of that pipe from July 5, 1905, until September 13, 1907, with considerable time taken out on account of the big fire, which destroyed the first shop. The total length of pipe was 70,480 feet of 22 inch inside diameter, with a thickness for a portion of 11/64ths of an inch, and for the remainder 3/16ths of an inch. The pipe was built to convey water from a point in the Carmel Valley to a reservoir just outside the town of Pacific Grove. The water was to be carried under a head varying from hydraulic grade to a maximum pressure, I believe, of about 140 pounds. 4738

The main difficulty that I encountered in the manufacture of this pipe was to get the firm to come up to the requirements of tightness in caulking. The requirement was that the pipe should stand a hydraulic pressure of 175 pounds per square inch before dipping. This was found to be very difficult by the manufacturer, and required considerable experimenting on his caulking, and some on the riveting, the tightness depending entirely on the steel, with no assistance whatever from the asphaltum dip. Theoretically, its bursting pressure would be about 750 pounds for the 3/16ths steel. I was detailed to be present during the manufacture of the pipe at all times, and to make all tests that seemed to be required. I was present at all times, watched all the operations by visiting the different processes, and when it seemed necessary, to make a test of the pipe, or at times when apparently there was no reason to make one, still to make one to be sure that they were up to the standard of tightness. The specifications permitted that 5% of the pipe might be tested by the inspector, and more if he deemed it necessary due to leaky pipes when found by the tests. While acting as inspector on that job, I made an analysis of the cost of doing the shop work on that pipe. I made three determinations at different times, and the table which you show me is the result of my determinations. I kept notes during the process as the work progressed, and at the completion of the contract I devoted some time to summarizing and making computations. 4739 4740

Questioned by Mr. McCutchen.

Referring to the information that the power required in the loading and unloading operation was 2 horse-power, and that it cost 72
4741 cents a day. There was no separate drive for the hoist from the line shaft, and the foreman and I made a determination as to how the power being delivered by that line shaft was distributed to the different machines. Those power plants were kept in operation 9 hours. I have estimated that this is the average power consumption. The average power for the day for the plant was so much, and it was distributed and consumed by various machines, and my conclusion was that this was the fair proportion of the total power paid for consumed by this machine. This power was supplied by electric motors. In determining the cost of power to this particular department, we could not assume that all machinery in the place was kept in constant operation during the 9 hours of the working day, for the reason
4742 that it was not always in motion. There were times when there were no cars to load; there were times when there were no sheets to punch. The charge for power is constant, whether there was any work to be done or not. This is what we considered to be the fair proportions of the power bought, which amounted to approximately $80 a month average. If this was not made on the basis of a total charge of $80 a month for power, it was made on the correct amount, whatever it was, and my remembrance is it was about $80. They had several punches in operation that were run by electric power. The only one used on our job was a large punch. Also a small hoist, a bevel shear, a riveting machine, and a small amount of power was used at the dipping kettle in hoisting pipe into the kettle and out, and then
4743 there was the power necessary to operate the air compressor for caulking.

The hoists used in this department were of a type I have not seen elsewhere, and were designed by the Byron Jackson Co. They were belt driven entirely through a section pulley from the line shaft. They were not compressed air hoists. The machinery operated by electric power in that place was a small traveling crane for loading and unloading; the punching machine; then the curving rolls; the bevel shears; the straight riveting machine; the hoist at the dipping machine, and the compressed air for caulking. I cannot say exactly as to the total horse-power supplied to this plant, because the plant was not used entirely on the work of this contract. Other pipes were being manufactured at the same time, of other sizes, for other people. I have determined the cost for power here upon the assumption that
4744 the power consumed on this work was a certain percentage of the total power supplied for the plant, and I determined these figures on the days and periods when the plant was running on our job. Some days they ran entirely on this work, whereas other days it perhaps had only a few men on it. If part of the crew was not busy, their

time was not charged to this job. I think there was no time that the men were lacking for work, but if they were not actively employed, being hired by the hour or by the day, they were laid off. I do not know what the charge for power throughout the year was. I made inquiries to find out what the power bill was for the month.

Questioned by Mr. Searls.

They pay for power by kilowatt hour, and there is a certain actual quantity at 4 cents per kilowatt hour.

Questioned by Mr. McCutchen.

I did not see the books of Montague & Co. These notes were taken by myself, and I do not know what their costs were. I think there 4745
was never a day on which they operated the crane more than 9 hours, but I cannot say positively as to that at this time. The crane was merely used for unloading and loading cars, which usually did not take the whole time. The first line of expense, power 2 h.p. 72 cents 4746
per day, I did not get that from my note book. These notes of mine, of course, are in different note books, and I do not suppose that the computations are available now, but I have worked out my original report in longhand, which I have at home, and it appeared this way on that. This is a detailed copy of that longhand report which I made to the man for whom I was working. It is an accurate copy. The report was addressed to Mr. Hunter, the resident engineer of the Monterey County Waterworks, for whom I was working at the time. We operated a compressor there, which was used for furnishing the compressed air to the caulking tools; they ran two of those caulking hammers, but I cannot say how many cubic feet of free air was required. It has been some time since I was familiar with the opera- 4747
tion of those, and I do not remember their requirement in air. The costs that I have detailed here are not all of the costs of every nature in connection with the manufacture of the pipe.

The tables showing the result of the witnesses' analysis of the cost of shop work was introduced and admitted in evidence as "Defendants' Exhibit 102".

With reference to these loading and unloading costs, I watched the operations by the day. For instance, they would work all day unloading a couple or three carloads of steel, and it would cost so much to unload the steel. I think I have memorandum that shows the expense over an entire day, but I have not a memorandum showing the 4748
cost of loading and unloading for the entire job. That would have been a good check, but I was not the time-keeper, nor the cost clerk on the job. I took those to find out for my own benefit approximately what the segregation of manufacturing charges was, as near as I could get them conveniently. I had other things to note besides the cost of manufacturing; the quality of the work was what I was there primarily to ascertain. I do not think I could get an accurate notion of the cost of loading and unloading from a record of one day, or of one

operation. I made a number of determinations to be reasonably sure that this was a fair conclusion. That is true of each of the operations. It was the general shipping gang who did the loading and unloading, and there was always plenty of other work available for those men, as I observed, when there was nothing for them to do unloading or loading. Our part of the work was the biggest job in the shop, and when any pipe was to be shipped, they were always put on that work,
4748½ and any steel coming in, they were always put on that work on account of demurrage. These men were first and foremost available on this main contract, and the rest of the time they were used on other work around the shop. When they were not loading and unloading, they were attending to the steel stock, but that had nothing to do with my job.

4749 The unloading of the steel involves taking it out of the car, putting it on a carriage, and wheeling it to the pile near the punch, so that it is never handled again from the time they let go of it until the punches take hold of it. That appears in the next charge. It may have occurred that I checked these men in some cases from the time they were at the side of the car from which the steel was to be unloaded, and kept their time up to the time that they had taken the last plate off, and were about to leave the job, but I took what I considered to be the average requirement for that. They did so much in so many hours, and perhaps it did not take them the full day to unload the full carload, and so they were only charged here with a rate of so much.

Questioned by Master.

If they finished in a portion of the day, they went to other work, and I paid no attention to that on our job. These items I have stated include no overhead, repairs and things of that kind.

Questioned by Mr. McCutchen.

4750 This shop was working on other things than ours, so these costs naturally would not have anything to do with the total cost of the shop. The first two determinations are parallel, but the third one is different. The third one is the actual cost of labor on this pipe from February 5, 1907, to May 11, 1907, compared with the actual price of pipe turned out for that amount of labor, and in that way it does accurately represent the cost of manufacture, leaving out overhead. I could not say what was paid for that pipe by the Monterey Water Co. There was great difficulty to get the naked steel to withstand a pressure of 175 pounds before dipping, as the thickness of the sheet was
4751 11/64ths for some, and 3/16ths of an inch for another portion. They did get it tight before the coating was added. They determined that it required what is known as fullering, which is an operation in caulking, involving the use of a round faced tool; its object is to back the metal up and cause it to thicken itself. That operation was not considered necessary when they first started the work, but they found it

was necessary in order to get a greater thickness to work on. It is a part of the caulking operation, but it is not always required. I consider that this pipe was properly manufactured. In order to establish a standard for their own workmen to go by, they had to submit to a considerable number of tests in the early stages of the operation in order to find out what was required that the pipe should pass the specification, and they found that the quality of the caulking which they started out to do was not sufficient, and they had to elaborate it, and go to more expense than they thought they would be required to go 4752
to in order to get it tight. The figures in 1 and 2 were derived by observing the output for a length of time, usually half a day or a day, and sometimes several days. I had no opportunity to know whether the costs derived by Montague & Co. for the carrying on of their shop accorded with my costs. I was never given the cost of the pipe to the Monterey Water Co.

RE-DIRECT EXAMINATION BY MR. SEARLS.

My information as to wages paid was obtained from the company's payrolls.

RE-CROSS EXAMINATION BY MR. McCUTCHEN.

The wages are all stated here in detail. The compressor was 4753
belted to a motor. I am not sure whether that particular motor ran anything other than a compressor. I think 9 horse-power was required to drive the motor. I think it had an individual drive, and was not used on anything else but the compressor. The motor that operated the hoist was driven from a line shaft, and the power that drove that shaft was distributed through several machines. The two cranes were not operated by independent motors. The loading and unloading cranes were driven from this line shaft, whereas the kettle hoist, I think, had a separate motor which did nothing but operate the hoist at the dip kettle. I could not remember the size of that motor. I think I have a note of the sizes of the different motors, but what 4754
each one did I am not sure of. There were three motors in the establishment, but I would not be able to say what the aggregate power required to operate them was.

Questioned by Mr. Searls.

The methods of manufacturing pipe in works have improved. To a certain extent I have had something to do with the manufacture of pipe since these were manufactured. As assistant engineer of the 4755
Panama-Pacific International Exposition Company, I had charge of the installation of pipes in the water and gas system out there, and it was part of my duty to visit the works of the Schaw-Batcher Co., in South San Francisco, and inspect some work they were doing for us there. While on those several visits, I took occasion to compare their methods with the ones we had used years before in Montague's

shop. I consider the methods they used in fabrication as improved. The machines were much more improved, and that in my estimation would lessen the cost of fabrication in the shop.

Questioned by Mr. McCutchen.

I could not say anything about the costs of the Schaw-Batcher Co. The dipping is the only one I have had anything to do with in
4756 the Schaw-Batcher shop. That is what they were doing for us, and I have no check on the costs indicated in this memorandum other than the dipping.

Questioned by Mr. Hazen: Each length of pipe was weighed, and was paid for per pound. This is actual weight, and I think is correct. That was completed pipe after dipping, and included rivets. The weight undipped, which I have a statement of, was actual weight also. They made a few weighings in order to find out how many pounds of
4757 dip adhered to the pipe.

Mr. Hazen: All of the pipe that I have ever had to do with has been bottle-tight before it was dipped. That was always understood; I tested it at 300 pounds pressure, and special test at 1,000 pounds pressure. I understood that that was what the witness said here, but I was interested in what he said as showing the usual shop practice in San Francisco.

Questioned by Master.

Mr. Hazen: I know what my total figures on the submerged pipe are: For the old pipes $165,000, for the two new pipe, $262,000. That is what is covered by structure 22; it does not include the gates and wharves, and various appurtenances which might be considered a part of those pipes. The last structures are additional, and appear under other headings in the schedule. That makes a total of $427,000.

4759 Mr. Rhodes: I am not familiar with the wages paid in 1913 for similar work on an 8 hour day. They might be higher in some shops; I am not sure that Montague has changed at all. I could not say what wages were paid for similar work in 1913.

Mr. Searls: Mr. Dillman's totals seem to be $284,844.

Mr. Dockweiler: And mine are $286,110.44.

Hazen

Allen Hazen recalled for Plaintiff.

4760 Mr. Hazen: I have prepared here a statistical summary of some of the physical facts with regard to this submerged crossing, and also an outline of my estimate, with a little supporting data, including the approximate cost of work represented by structure 22, made up from the contract prices. I have not any documentary evidence of the payments. The contract prices are clear from the paper.

Questioned by Mr. Searls.

My method of appraisal of these submarine pipes was not to take the cost, but I ascertained the cost of the 22 inch pipes. This work

was done in 1901 or 1902, but still I consider the cost as a substantial element in estimating the cost of reproduction. There is work at Vancouver which is fairly comparable to this, but I do not know of any other on this Coast. I never heard of running bran through pipes in 4761
caulking them.

Questioned by Mr. Greene.

I have never, in determining the cost of fabrication of pipe, ascertained shop costs by consulting the manufacturer, or placing an inspector to watch the process as it proceeds. The general method is one that I know about, and I spoke with reference to the general method 4762
rather than its particular application to making pipes. When an inspector is put on work, it is common to have him keep a cost record of the work. Cost records made up in that way are of some interest, and of some value, but in my experience the men always leave out important items. To take those reports without consideration of that fact is certain to be misleading, and I do not remember that I have ever made any important estimates on that kind of evidence alone.

Questioned by Mr. Searls.

I do not know what Mr. Rhodes left out of his computation, but I am certain that he could not get the costs by going into a shop as a visitor in that way, according to my experience with that sort of data, or of similar data. As a fundamental principle you cannot get any- 4763
thing that is any good in that line unless a man starts with a whole payroll, and subdivides it so that all the payroll is charged against some item that is accounted for. I didn't understand that that is what he did. What I mean is, to know what it costs to make pipe in that shop, it would be necessary to take the payrolls of the shop for some considerable period and distribute them, so that every item in the payroll would be charged against some piece of pipe. I don't think there is anything to show that the other items in the payroll in this particular case could not be charged against some work that is going on. Based on experience with men, I do not think any man in 4764
a shop in that way could get the whole labor cost. I have never run a shop, but I have had my inspectors in a great many shops, and I have visited them. I have not had any experience from the standpoint of a pipe manufacturer.

RE-DIRECT EXAMINATION BY MR. GREENE.

This schedule shows some of the dimensions and weights of the 4765
two lines. There are four lines of pipe, two 16 inch, and two 22 inch. The 16 inch pipe were laid first in 1887 to 1888, and the 22 inch pipe in 1901 to 1902. The flexible joints were shrunk on, and riveted to the steel pipes, and in that way the pipes were given a strength and perhaps a power of resisting earthquake shock that they would not have had if they had been made all of cast-iron. I never heard of pipes being laid in just this way until I found these lines. I have

since found that a line at Portland, Oregon, was laid by substantially the same method, but at a later date than the first one.

The steel tubes were made in Pittsburg, and were welded pipes. The bells, which are shrunk and riveted on, are castings. The casting as first made is considerably larger and heavier than it is in the final form. After it is cast it is poured to make it fit the pipe, thereby turning off the excess of casting at that point (referring to a drawing). This part is turned at about a spherical surface; that has to be done with the utmost precision, because the joint has to be made so perfect that this can turn in any direction after it is made, without leaving a leak. The work on the interior of this casting is perhaps comparable to the grade of work in finishing up an engine cylinder, and is not at all comparable to the kind of work that is done in other cast-iron pipe work. This smaller casting is also poured so that it may be forced on to this tube, and the surfaces are turned; the same care is not required with that as is required on the other work.

4766

These pipes were galvanized after being received in San Francisco. Then they were dipped in the Spring Valley dip. Then these castings were forced on by hydraulic pressure, and drill holes were made through the casting and through the pipe, and these rivets were put on; then the ends of the plate were caulked solid to the casting, so as to make it perfectly water-tight. The pipes made up in that way were transported to the site of the work, and then were laid, being put together above water on barges that were anchored to piles driven for that purpose to hold them in position, and gradually taken across from one side to the other, this pipe being put together in lengths, and paid out over the back end of the barge as the work proceeded. The flexibility of the pipe permitted it to bend, so that it found its way to the bottom, and was left on the bottom on the ground.

Questioned by Mr. Searls.

There is no flange. It is kept from slipping out by the fact that this spherical surface cannot get by here. That gives it its strength. This joint is run with lead in the ordinary way of making a pipe joint, except that this is a very heavy lead joint, and the curves hold the lead so that when it moves the lead always goes with the male end of the joint, and so that it slips freely on the female end. Submerged pipes with this form of flexible joints have been very freely used in the United States and on the Pacific Coast. There have been several lines at Portland, Oregon, and at Vancouver.

4767

The record of the cost of laying the 22 inch line I have in approximately complete form, and it is shown by the last sheet. The contract for the laying of 13,500 feet of pipe was $10.90 per foot $147,158. There was a bonus I think for completing the work ahead of time, although it may be that some other element was involved; at any rate a payment of $4.725 was made. The pipe itself cost $57,700; galvanizing, from the actual bill, $19,039; the dipping was done by

the Spring Valley Water Co., and I have no record of the cost; I take the cost as agreed with Mr. Dockweiler for that, amounting to $2,970. That adds up $231,592. I do not believe that was the whole cost of the night work. This is made up from the contract items, and there must have been minor and incidental expenses, so that I should say in a general way that the probable cost of that work was about $240,000, exclusive of overhead and connections. 4768

Questioned by Master.

I mean by the connections all the fittings and gates that connected the riveted pipe with the submerged pipes on the several sides, and which are included under other items. In addition to this information as to cost, I myself have laid two lines of 30 inch pipe under the Connecticut River at Springfield, Mass., following a somewhat different method, but giving a crossing with about the same capacity in the aggregate as this crossing. The cost of that work was $39.90 per lineal foot per each line. I have also had the engineering responsibility for a 24 inch line of submerged pipe about 4 000 feet long, at Superior, Wis., for a good many years, and have had occasion to lower it, repair it, inspect it, and do various things with it, so that I have learned a good deal about the peculiarities of these spherical joints. I also inquired as to the cost of submerged pipe work at Portland, Oregon, and at Vancouver. The conditions at Vancouver in many respects are very similar to those at this crossing. The conditions at Portland are different in many respects. The description of the Portland lines is contained in a paper presented to the American Society of Civil Engineers, December 16, 1914, by D. D. Clark, the engineer and superintendent of the Portland works. From this it appears that in 1894 the first line across the river was laid, 2,006 feet of 28 inch pipe, at a cost of $37.66 per lineal foot. The second line of 24 inch pipe was laid in 1898, and consisted of 2,042 feet of lap welded steel pipe, being very much like this crossing in San Francisco, and the cost of that was $20.50 per lineal foot. The third line was 30 inch lap welded steel, galvanized 4769 and asphalted, and in the same method as the Spring Valley pipes laid in 1910, 1911, and the cost in the statement is combined with the cost of some other pipe on the shore; in making an approximate separation, the cost of the submerged portion of the pipe was about $45 a lineal foot.

Questioned by Mr. Searls.

I made that segregation, based on the figures that appear in Mr. Clark's statement. That is an approximate segregation, and an approximate figure.

RE-DIRECT EXAMINATION BY MR. GREENE.

At Vancouver they used no steel at all; it was all cast-iron pipe. The casting is the whole 12 feet length, and is machined in this way:

They have laid a great many of these lines; it is comparable to the Spring Valley pipe in several respects. The depth of the water is practically the same; the tidal currents are very strong in both cases, and no dredging is necessary, the pipe being laid in all cases without preparation of the bottom, as is the case here. They have had a great deal of experience in Vancouver in the method of doing the work successfully. In the lines that have been laid recently, not affected by war prices, but otherwise nearly up to date, on inquiry I learned that the cost of the material of an 18 inch pipe, the size they are using now, is about $12 per lineal foot, and the cost of laying it is about $11.50 per lineal foot, making a total cost of
4770 $23.50 per lineal foot. That is for cast-iron pipe. For these pipes I have estimated the pipe itself at 4½ cents a pound at San Francisco; the bells, including the boring, turning, shrinking on and riveting, at 8 cents a pound on the actual weight, and I got Mr. Lawrence to weigh some of them that were left over, so that I should get this right. The galvanizing at 1½ cents a pound, that being the contract price for galvanizing on the 22 inch pipe. The dipping at 1 cent a pound per inch of diameter as I agreed. The lead at 5 cents per pound. The transporting from the shop to the work, laying, testing and making tight, I allowed $6.75 for the larger pipe, and $6.25 for the smaller pipe, making the total cost $262,500, or $19.30 per foot for the 22 inch pipe, and $12.20 for the 16 inch pipe. Those totals differ a little from the ones I made up last year. In making up this schedule, it did not exactly check the first calculations. That comes out $262,500 for the 22 inch pipe, and the actual cost of this pipe, with a few items estimated, was about $240,000 in 1901 or 1902. So my estimate is about 9% in addition to the actual cost at that time for those pipes.

The materials, I think, would perhaps cost not any different from what they did at that time. The labor cost would be greater at the present time. These prices that I have set on this pipe are very low ones, as submerged pipe work has been done in the United States, and I think it is an extremely creditable piece of work in that respect. The pipes have been tight; there has been no repair to them whatever since they were laid, and they are believed to be perfectly tight at the present time. That is an almost unequaled record. If I had not had these actual costs of 1901 and 1902 before
4771 me, from what I have ascertained as to the cost of submerged pipe elsewhere in the United States, I am quite sure I should have estimated somewhat more the cost of reproduction than I actually did. There is a record of the old contract price on the 16 inch pipe of, I think, $9.50 in place of the $10.90 on the larger pipe. I think none of the other costs are available on that. The 16 inch pipe is made up practically in proportion to the figures for the 22 inch pipe. The next sheet shows some details from the inspector's notes and the

actual weights of the pipe. The next sheet contains a few purchases of welded pipe, somewhat comparable to this, and which I took into account in reaching the price of 4½ cents per pound for the pipe.

The formula on the next to the last page of the exhibit I used in computing the weight of this welded pipe, and I may say that this welded pipe differs from the riveted pipe in two respects: In the first place, a 22 inch pipe means that it is 22 inches in diameter on the outside, while ordinarily, and on all other pipe, when we say 22 inch pipe, we mean 22 inch pipe inside. Then with this welded pipe there is no riveting or no lap, so it is a simpler and more certain process to compute the weight than it is with the riveted pipe. This is simply an arithmetical formula for computing the theoretical weight of the pipe, and then 5% was added for over-run.

Questioned by Mr. Searls.

I made that formula for this purpose, and deduced it out of my head. D is the diameter; T is the thickness. D — T is the 4772
diameter minus the thickness, and that gives the diameter of a ring halfway between the inside and the outside of the plate. Multiplying that by T and by Pi, which is the symbol of the ratio between the diameter and the circumference of a circle, and by 490 pounds per cubic foot, as the weight of the metal, and divide it by 144 inches in a square foot, gives the theoretical weight of the pipe. That is what it would weigh if it were just exactly the nominal dimensions; it will certainly weigh more than that, because pipe will be rejected if it falls below the nominal dimensions. We know from the actual weight records that it overran in this case, and so I added 5% to cover that. When I say 490 pounds, I mean that a solid block of this metal, containing a cubic foot, would weigh 490 pounds, and that is a generally accepted figure.

The schedule of 4 sheets was received and marked "Plaintiff's Exhibits 98n, 98o, 98p, 98q".

Witness: J. H. Dockweiler for Defendants. Dockweiler

RE-DIRECT EXAMINATION BY MR. SEARLS.

Structure 22, item 1, page 163 of my inventory: 16 inch o. d. 4773
lap welded steel, 5/16 pipe, galvanized, 710,118 pounds. My figure for that is 5.6 cents per pound, which is on a quotation from Crane & Co., July 2, 1914, f.o.b. San Francisco. Laying and cost to handle I have under the heading of the joint.

Mr. Hazen: I received a quotation from the New Jersey Tube Co. for 3.60 per foot for the pipe without galvanizing. It is about 4 cents per pound, and is f.o.b. San Francisco. That was a quotation on July 5 of this year, when prices were rather low. Mr. Metcalf

4774 says that my galvanizing price agrees very closely with Mr. Dockweiler's.

Mr. Metcalf: It is 6 cents, as against Mr. Dockweiler's 5.6.

Mr. Dockweiler: That is merely the tube. As far as we have gone our prices are identical on the 22 inch. On the 16 inch I am 5.6, as against your 6 cents, galvanized, f.o.b. San Francisco.

Mr. Metcalf: It is my impression that that closely parallels it. That is, the pipe and the galvanizing without the dipping.

Mr. Dockweiler: There is no dipping at all; this is merely the material delivered, galvanized.

Mr. Dockweiler: For the 16 o.d. lap welded steel, 710,118 pounds, in the inventory 5.6 cents a pound, making a total of $39,-
4775 766.61. Then for my 22 inch o.d. lap welded steel, ⅜ inch pipe galvanized, 1,077,882 pounds at 6 cents, making a total of $70,672.92. The next item is dipping, 111,691 square feet at 2 cents per square foot, $2,233.82. That is for the 16 inch. The dipping on the 22 inch is for 153,952 square feet at 2 cents per sq. foot, $3,079.04.

Mr. Hazen: I check you on that.

Mr. Searls: Mr. Dockweiler is $30 higher.

Mr. Dockweiler: Painting the bells: 7,950 feet on the 16 inch pipe, 1.3 cents per square foot, $103.35. Painting bells on the 22 inch, 11,900 square feet at 1.3 cents a square foot, $154.70.

Mr. Hazen: My painting is included is the figure of $6.75 and $6.25 per foot.

Mr. Dockweiler: That is for one coat of paint. They were subsequently dipped, as I understand it.

Mr. Hazen: We will accept that.

Mr. Dockweiler: The next is furnishing 360,500 pounds c.i. bells, riveting on, machining, laying pipe, (including rental of barge, tug-boat service, etc.), 700 lengths, $75 each length, $52,500.

4776 Mr. Hazen: I have for the bells $30,500; for the lead $6,400; for the laying $8,500.

Mr. Dockweiler: Cost of laying 16 inch pipe: Bell and nipple; machining, drilling, riveting holes, cleaning end of tube, shrinking, drilling, constructing pipe, riveting, 508 pounds at 8 cents, $40.64 per joint.

Mr. Hazen: 8 cents per pound is what I use. I think that the actual weight of the bells is considerably more than the amount shown in this agreed schedule. In this case when I examined the schedule I did not believe that that material could be produced for that weight so I got Mr. Lawrence to weigh some of it.

4778 Mr. Dockweiler: I assumed the weight at 508 pounds.

Mr. Hazen: I have 190 tons on the 16 inch, in place of 180, and 493 tons on the 22 inch, in place of 471.

Mr. Dockweiler: I made a computation from the drawing, and tried to arrive at it in that way.

Mr. Hazen: Just what I thought happened. The actual weight always over-run those calculations.

Mr. Dockweiler: The inventory figure for the 16 inch is 360,500, and that is for the bells. The bells on the 22 inch are 942,200 4779
pounds. There are 700 lengths of 16, and 700 lengths of 22, and I only used 700 lengths in conformity with the inventory. Divide 360,500 by 700 which would give 515 pounds per bell, as against 508 pounds which I used. Whatever the facts are, I used 508 pounds, but dividing the given weight by the number of lengths, it figures 515 pounds per bell. For the 22 inch I used 1,346 pounds. I didn't carry it out in dollars. For my lead I took 77 pounds at 5 cents, $3.85 a joint. 4780

Mr. Hazen: I have 64 tons for my lead figure, or 180 pounds for the 16 inch. I figured the weight of the lead from the measurements of the pipes down at Millbrae, and I measured the pipes myself.

Mr. Dockweiler: I only had the diagram furnished by the company, which is a Spring Valley record referred to as X-82.

Mr. Hazen: My reference was X-97.

Mr. Dockweiler: The next is tug-boats and barge, crew, etc., 4781
$15.83 per joint. That gives me a total of $59.82. Then I have profits, insurance and incidentals, $14.96 a joint, which gives me a total of $74.78, which I rounded off to $75 per ton. The weight per cubic inch of lead is .41 of a pound. I arrive at the laying cost of $15.83 as follows: Tugboat and barge service per joint $2.94; rental of laying-barge and equipment $4.33 per joint; fuel oil, waste etc., 41 cents per joint; crew $5.77 per joint; launch $1.88 per joint; Healy & Tibbits give cost of unloading barge fully equipped for 4782
above work, excepting the chutes and main cable at $15,000. They are contractors who do a vast amount of harbor work in this way, and they have equipment of this nature, and so I went to them for data. Healy & Tibbits give cost of unloading barge fully equipped for above work, except chutes and main cable at $15,000.

(Scow at $10,000 and equipment $5,000)		$15,000
Small scow suitable for anchor work cost the Southern Pacific (the same figure taken by me)		2,000
5 inch circumference steel cable, 6500 feet long, at 4 pounds to the foot, 26,650 pounds at 10 cents	$2,665	
8-1500 pound anchors, 12,000 pounds at 4 cents a pound	480	
Other equipment	455	
Total for that		3,500

Scow, life taken at ten years, annual charge 10% of 12,000	1,200	
Equipment taken at 5 years annual charge 20% of 8,500	1,700	
Interest on $20,500 at 6%	1,230	
Repairs: 10% on $20,000	2,000	
Total for 200 working days		6,130
Total for one working day		30.65

This is a 90 day job. 90 times 30.65, $2,758.50.

4782a Chutes: Are estimated from the Spring Valley Water Company's photographs Nos. 374 to 385.

There are 5,000 feet B.M. rough Oregon Pine, in place at $35	$175	
650 pounds of wrought iron in place 4 cents	26	
150 lineal feet of 35 pound steel rails, 1750 lbs., at 4 cents	70	
Making a total of		$271
Adding that to $2,758.50, makes a total cost per job of equipment		3,029

Cost per joint $3,029.50 divided by 700 joints equals $4.33 per joint.

Fuel: 3 barrels of oil per day at .75		2.25
Oil and waste		1.00
Per day		$3.25

Crew:

1 Foreman at $200	6.67	per day
1 Engineer, 150	5.00	"
1 Fireman, 75	2.50	"
2 Pipe men, 4	8.00	"
8 Laborers, 3	24.00	"
Total crew	$46.17	

I do not think those men work on Sundays, but I rate an engineer and fireman who have to clean up equipment and things like that as having to do clean up work on Sundays. The other men are paid by the day.

Towing service: Spring Valley Co.'s photos of pipe being towed to laying-barge show over 30 lengths per load. 8 lengths laid per
4783 day at 3300 pounds equal 13 tons per day.

Equipment:

1 Tug every three days: 86 divided by 3 equals 29 days at $40 equals	$1160
2-50-ton barges per job: 90 times 2, 180 days, at $5 a day	900
Total	$2060

Rental rates from Healy & Tibbits $2,060, divided by 700 equals $2.94 per joint.

Launch rentals: 1 launch per month $15 per day; the Crowley Launch Co. is the authority for that. I have given you tugboat and barge service at $2.94 per joint. I gave you rental for laying barge and equipment $4.33 per joint. Fuel oil and waste ⅛ of a day $3.25. That is 41 cents per joint. The crew ⅛ day, 46.17, 5.77 per joint; in other words the crew runs 8 joints per day. The launch ⅛ of a day at $15, or $1.88 per joint. That accounts for the $15.83 in the estimate for tugboat and barge, crew, etc.

The riveting on bells, and the machining is $75. $40.60 per joint 4784
was the cost of the material and the machining. That is the finished bell. The lead was $3.85; the labor of handling scow and barging it, and laying it was $15.83, which brought my figure to $59.82; then I allowed for profit etc. $14.96, or a total of $74.78, which I have rounded off to $75, which appears opposite my item for 700 lengths for furnishing the 360,500 pounds of c.i. bell, riveting on, machining, laying pipe, including rental of barges, tugboats, etc., the total of that being $52,500.

Mr. Metcalf: There is a difference in the laying. That figures up something like $52,500, as against $122,000.

Mr. Dockweiler: This pipe was made in a rush, and with these 4785
conditions surrounding it, it was natural for a contractor to bid high, because if he did not finish within the time, he lost his entire investment.

Questioned by Mr. McCutchen.

I allowed for the laying of so many lengths a day, and that was the number of lengths which they did lay per day. I counted it just as much of a rush as the rush under which the work was done, but this is a thing which has been done, and it is easy after a thing has been done to know what you can do. I am not going to make the company suffer for its experience. At least not more so than when a company estimates that it is going to put in a cut 100 feet long and 3 feet deep, and it finds it has to make one 300 feet long and 10 feet deep—we allowed for the fact just as found. 4786

I assumed every condition that I found to exist in the performance of this contract, and that is where I have an advantage in estimating the cost of work that has been done, and I am able to estimate closer. Your allowance for contingencies is very much less as against work of a nature such as is in question, where you are figuring on the future, and you don't know the nature of the contingencies which confront you. There is no contingency here as to time. I am estimating work now, and in estimating the cost of it, I am allowing a high percentage for contingencies, but if I knew the history of a work, and the conditions that have been encoun- 4787
tered, it would not be necessary to estimate at all for that percentage

of contingency. That is the advantage that a man has who knows the history of a work in estimating what it will cost to reproduce that work, as against the man who stands upon an uncharted sea
4788 for instance. What I mean is, this contractor, assuming of course that there is a difference of time here, but assuming that the time in which it is built is the same as the time in which I estimated it, that he made $6 per foot, or whatever the unit is, more than the profit that I would ordinarily allow. That is, he had to do a very good job. On the first figure he had a right to make a charge for contingencies, and any contractor now can reproduce those pipes for what I am estimating them. I did not estimate that the contractor would work at night, and I do not know that this contractor did. At the time this pipe line was laid there was a great rush to get in water, as there was a shortage of water; I am basing this statement
4789 on what Mr. Schussler has testified to in the past. This work was done from November to January. There were 294 double lengths
4790 laid from the period November 3, 1901 to January 18, 1902. Those were all fair days at a full day's work each day, and from the period November 3rd to December 27 you worked 53 days out of 55. That is what your progress profile shows. If they laid off, then the average is so much. It is just the same if you laid off half of the time, as then they actually laid 16 pipes a day. I am taking the total time that they worked, and dividing the output into that time. That gives me the average of that at so much. I am taking the time of the contractor, and I am assuming that my contractor has the advantage of the benefit of that work; he has the advantage of modern improvements to whatever extent they are available to him.

Cost of laying 22-inch pipe, bell and nipple; machining, drilling 48 riveted holes, 2-inch by 13-16 inch, cleaning ends of tubes, shrinking on, drilling and counter sinking pipe, riveting, caulking, etc. 1346 pounds at 8c.	$107.68	per	joint
Lead, 226 pounds at 5c.	11.30	"	"
Tugboat and barge service	2.94	"	"
Rental of laying barge and equipment	4.33	"	"
Fuel oil, waste, etc.	.41	"	"
Crew	5.77	"	"
Launch	1.88	"	"
Total	134.31		
Profit, insurance and so forth 25%	33.58		
Total cost per joint 22 inch pipe laying	$167.89		

which I rounded off to $168 per joint, and which is my unit cost appearing opposite the 700 lengths of 22 inch pipe. The total of that is $117,600.

Questioned by Mr. McCutchen.

A man coming along after the contractor who laid the pipe would have the benefit of his experience, but if he was the only man 4792
who could do it, he could raise his price; if he were cognizant that it was common knowledge among men who had a desire to bid, he would adjust his figures along the lines of the figures which I have given you, and for which I have estimated the work can be done. I think this work was laid by the Risdon Iron Works. As a matter of fact, this work was done by a man who was laying pipe for Mr. Spreckels at San Diego, but you will note that there are quite a number of improvements in laying submarine pipes that have been installed since then. There was a ⅝ inch cable employed for the laying of each line, and that was charged in on the work; now a man going and laying these four lines at once, he would just ship that cable over and use it. He would have that advantage. The man who built the line used two cables, as I understand it. He used one cable the first time to line in his barge, and lay the first double line. Then several years afterwards another cable was used. I am figuring only on one cable, and I am not definite on whether he had 4793
more than one. A cable that had laid in salt water for several years, in all likelihood would not be of much service for the second job. 4794

To briefly state the principal requirements of the San Diego specifications: First, the work must be done in days of 8 hours, page 7 of the specifications; water for settling the backfill will be charged to the contractor, page 8; in case of stoppage of work by injunction, contractor has no redress, page 8; no boulders or rocks to be left in the trench, page 11; any irregularities in the bottom of the trench must be filled and rammed to grade before the pipe is laid, page 12; utmost care must be used in backfilling, page 14.

Questioned by Mr. Greene. 4795

All pipe shall be built to stand a thorough hammer testing while under the following hydraulic pressures:

For 6 inch and 8 inch pipe	500	pounds	per	square	inch.
For 10 inch and 12 inch pipe	400	"	"	"	"
And for larger sizes	300	"	"	"	"

As soon as any section of pipe between any two gate valves is laid, or when directed by the hydraulic engineer, the same shall be tested by hydraulic pressure, the pressure shall be brought up to 300 pounds per square inch for 4 inch—then it recites various requirements, and finally winds up with and 200 pounds per square inch for all larger sizes, and while under this pressure each pipe shall be thoroughly hammer tested from end to end. Any pipe which exhibits any defect shall be taken out and replaced by a sound pipe. As I read these tests, the hammer test is for cast-iron, but these

bids are for wrought iron pipe, sheet steel, and these are the standard plans and specifications. The pressure tests, I should judge, are to be applied to wrought iron.

4796 Here is a test required on the steel pipe: For quarter inch the diameter is 24 inches, and it says here the shop test pressure is 300 pounds per square inch. For 20 inches thickness of plate ¼ inch, the shop test pressure in pounds is 350 pounds per square inch. Before coating, each section of pipe shall be subject to a hydrostatic pressure equal to 1½ times the allowable working pressure, and the pipe must, during said test, be absolutely free from leaks or fractures. Also before the pipe sections are coated, they shall be thoroughly cleansed by sand blasts, or other equally efficient means, so as to show in all parts the color of the metal.

Questioned by Mr. Searls.

That is rather a rigid specification.

Questioned by Mr. Greene.

There is nothing in here that I did not assume in figuring on the Spring Valley pipes for the system. This was not particularly onerous.

4797 The Master: I will mark this "Defendants' Exhibit 100k".

Mr. Dockweiler: The Western Pipe & Steel Co. bid for the pipe $62,400; they bid $3,000 for testing, making $65,400. Divide that by 30,000 feet, and it will give 2.18 per foot, which is equal to 2.91 cents per pound. That includes the metal and rivets. You get the 2.91 cents by dividing 2.18 by 75 pounds, which is the weight taken for the pipe per lineal foot. I divide 65,400 by 30,000 feet, the length of the job, and that gives you 2.18 a running foot.

4798 The Lacy Manufacturing Co., $68,100, testing $4,000, that makes $72,100, equal to $2.403 per foot, or equal to 3.2 cents per pound.

The Llewelyn Iron Works: Pipe $59,400, testing $3,000, total $62,400, equal $2.08 per lineal foot, or 2.77 cents per pound.

Reitter-Connolly Mfg. Co.: This is an eastern shop. All the other shops were western shops. Pipe $75,200, testing $10,000, total $85,300, equal to $2.843 per foot, or 3.79 per pound.

Marked as "Defendants' Exhibit 100-l".

I have some figures of Mr. Adams' to present.

Received and marked "Defendants' Exhibit 100m".

SIXTY-EIGHTH HEARING. NOVEMBER 29, 1915.

Witnesses: J. H. Dockweiler for Defendants.
Geo. L. Dillman for Defendants.
Allen Hazen for Plaintiff.
Leonard Metcalf for Plaintiff.
N. Randall Ellis for Defendants.
David Dorward for Defendants.

DIRECT EXAMINATION BY MR. SEARLS.

"Exhibit 100m" comprises two sheets of paper; the first sheet is 4800
a copy of the notes and computations as I received them from Mr.
Adams. The second sheet is a segregation by me of the item. The 4801
trenching and backfilling at 45 cents is my segregation. Mr. Adams did not give me the yardage per lineal foot, but I witnessed the construction of the work, and that is the yardage that I have computed, 2/3 of a yard per lineal foot.

Mr. Hazen: For a trench 5 feet deep, and a 24 inch pipe, that is not very far off. I think the excavation might run a little more than that; it depends upon the soil.

The principal difference between a steel job and a wrought iron 4802
job is in the cost of the metal. The average price of steel ¼ inch thick or thicker in Pittsburg is about 1½ cents a pound; with freight added to San Francisco it is about 2¼ cents a pound. The steel of the thickness in the Spring Valley system would average about 2.35 cents a pound in San Francisco as an average price running through the years, with pretty large fluctuations both up and down, and that might be compared with the 4 cents per pound which we used for the wrought iron, so that the added cost of the wrought iron would be 1.65 cents per pound. That is overlooking differences in the cost of manufacture that there may be. I think the number of rivets, and the seams with wrought iron is a good deal greater than it is with steel, and the cost of manufacture of wrought iron is somewhat greater than the cost of manufacture of steel; the manufacturing cost difference is not a large one, being a matter of only a few tenths cents per pound. The wrought iron plates would cost 70% more than steel plates f. o. b. San Francisco. I think it is true that the largest steel 4803
sheets would not be used for the smallest pipes. Steel sheets can be obtained in very large sizes, and if these pipes were to be made of steel, the sizes that would be selected would be very much greater than the present wrought iron sizes. The cost of the circular riveting is quite an element, if it is thoroughly done. If the rivets are driven hot, and held until they lose their redness before the hydraulic tool is taken off, the cost of riveting is quite an item. If they put the rivets in cold, and run them through a roller, as is done in some mills, the cost is very small.

4804 Mr. Hazen questioned by Mr. Searls.

I did not attempt to segregate the different parts of the manufacture which go to make up the figure of 3.75 per pound. That was based on experience in buying and selling the materials, and includes not only the labor cost, but the profit that ordinarily goes with the business. I could not make an estimate of what part of that 3.75 is taken up by riveting. It is very much more in some shops, and less in others.

Mr. Dockweiler: The 70% that Mr. Hazen used was the cost of the bare plates. The way I get at the cost of fabricated iron plate is to take 20% of the total cost of steel pipe material and fabrication, add 20% to that, which gives me the figure for wrought iron pipe as interpretating the Lacy bids as set forth in their letter. We both may be correct. Mr. Hazen takes only the bare cost of the metal, while I take the cost of fabricated pipe. My estimate for steel in this city is 2½ cents per pound, including the rivets, while Mr. Hazen's is 2.35 cents per pound. We both agree on our estimates for the metal of the iron pipes.

4806 Mr. Dillman: I have not any definite figures in regard to the comparison as between steel and iron. My impression is that the Allan Wood iron quotations that I have had in the past usually average about 25% higher for the manufactured pipe than for the steel pipe f. o. b. San Francisco.

Mr. Hazen: Mr. Searls asked me the other day if I could back up all that Mr. Schussler said about this pipe. The early specifications I have not been able to find, as they were lost in the fire. Mr. Schussler has told me how the earliest pipe was made, and the point he has told me about particularly is that when he got the first order of iron in this country he insisted on a good iron as he had been getting from Scotland, and that in order to accomplish that it was necessary to pile up the pieces in special piles with a special kind of cover plates, and to heat them and roll them out. I have been looking for an independent corroboration of that, and until the other day I had not got it. As the result of an inquiry which I sent to Pittsburg through my father-in-law, who is a resident of Pittsburg—I gave
4807 him the name of Oliver, and asked him to look up the predecessors of the Oliver Steel Co., and see if there was any old foreman or anyone that he could find who had been in the Oliver Mill, who would remember about these plates, and could tell me how they were rolled. My correspondence with him is in a letter which I will read:

"MEMORANDUM RELATING TO THE MANUFACTURE AND DELIVERY OF AN ORDER FOR IRON PLATES SOMETIME BETWEEN 1880 AND 1890.

"I cannot fix the exact time and I have been unable to procure "any data which would help me in fixing the exact date, but some- "where within the period named, the firm of Oliver Brothers &

"Phillips, of Pittsburg, of which I was the General Manager, received "from Huntington, Hopkins & Co., of San Francisco, California, a "large order for iron plates, to be delivered to the Spring Valley "Water Co., of San Francisco.

"The specifications for these plates showed that they were to be "of a high quality, and we soon found that our usual method of 4808
"making iron plates would not meet the requirements, and we had a "great deal of trouble and expense before we succeeded. The plates "had to be perfect on the surface, and the inspection was so severe "as to make them, so far as appearances were concerned, the equal "of boiler plate.

"We finally succeeded in meeting the requirements by the use of "hammered iron slabs for tops and bottoms from the piles from which "the plates were made, and even with the use of tops and bottoms, we "found it necessary to give the piles what in mill parlance is called "'wash heat', all this adding to the expense, but it enabled us to fill "the order to their satisfaction. Then, again, in shipping the plates, "great care had to be taken to protect them from dampness in transit, "as we understood from one of our men whom we sent out to Cali- "fornia, that the German engineer in charge of the work had a "peculiar paint, which required a perfect, smooth, sound, metallic "surface to be effective, and that he was unrelenting in requiring the "specifications to be filled in every respect.

"The plates, as we understood, were to be used for a water line, "and I think the pipe was to be about 36 inches in diameter, and of "varying thickness, owing to the fact that it climbed hills and went "into valleys, and a varying pressure had to be provided for.

"I was told at the time that two large plate manufacturers, one "in the East, and one in Pittsburg, had undertaken the order, but "owing to the strict requirements, had given it up, but we got through "with it, and I think we succeeded in turning out a lot of material "which we could stand by. "DAVID B. OLIVER,

"Pittsburg,
"Nov. 18th, 1915."

That corroborates Mr. Schussler's statement. 4809

With regard to a No. 9 gage, all the No. 9 in the system, except that which I mentioned, seems to have been the Scotch iron. I think the presumption may be that that is the Birmingham gage. It is a comparatively small amount, and I think you can accept that. Mr. Dockweiler and I agreed on the rest of the No. 9 gage exactly, so that it would not make any difference.

Mr. Dockweiler: The Sacramento Job: Page 28, Section 26 of 4810
the specifications; the excavation shall be sufficient at all field joints to allow the work of riveting and calking to be properly done and inspected. The dimensions of seams, laps, rivets, etc., is provided for 4811

on page 34 of specifications, Section 58. The punching is provided for; the shop riveting is provided for; the beveling of the plates and the calking; the junction of the circumferential and longitudinal seams is provided for; and the testing. The provision for riveting at the junction of the circumferential and longitudinal seams is that the plate must be scarfed to a thin edge, through which the rivets on the circumferential seam shall be driven. There is a provision that all rivets shall be driven hot, and until the rivet head has lost its redness. That complies with Mr. Hazen's requirements for a good job. The Schaw-Batcher Co. were the successful bidders under this call. Laying is provided for, and a great deal of precaution is set forth regarding this, even to the extent that
4812 no person shall go into the pipe at any time without wearing rubber boots or soft slippers. I consider that extraordinary under ordinary conditions. The ordinary Spring Valley coating would not call for that, as it sticks on better than this coating that the ordinary shop men put on. Then there is re-coating at such places where there is any injury done; in other words, that requirement is the same, I should judge, as for the Spring Valley work. That is always a standard call, and is not an unusually onerous requirement. There are several provisions for inspection; there is a testing of the pipe after it is laid, then the contractor must give three bonds; first, a guarantee bond; second, a material and labor bond; and third, for the material and workmanship done, which latter bond applies to 5% of the amount of the contract, and is to hold good for a period of one year after completion and acceptance of the work.

4813 Questioned by Mr. McCutchen.

I do not understand that the portions I have read are unusual. They are rigid, and I should hold these specifications to be in the line of the Spring Valley requirements for good work, and I consider Spring Valley's specifications rigid. These are requirements that would make for very high-class work. If you were going to lay a pipe that would just flow ordinarily as a conduit, not under pressure, you would not want a call of this nature. The bids on this Sacramento job were made on first-class engineering specifications, and they are specifications that would give you equally as good workmanship as the Spring Valley workmanship.

The point finally resolves itself to this statement, that after de-
4814 ducting the price of the steel and the rivets, I ascertained the cost of the steel on this job as 1.75 cents per pound in San Francisco f. o. b.; that the rivets were 2½ cents per pound f. o. b. That for the 20 inch 3/16 inch gage, after deducting the cost of the steel and the rivets, we obtained the cost of fabrication, which includes dipping, cost of loading on cars at factory, cost of unloading at Sacramento, hauling to the trench, excavating for trench, laying pipe and fittings in trench and backfilling—of 3.05 cents per pound. That for the 24 inch 3/16

inch gage it is 3.12 cents per pound. For the 30 inch ¼ inch gage it is 1.93 cents per pound. For the 36 inch ¼ inch gage it is 1.89 cents per pound. In other words, that with all these requirements calling for first-class work, the pipe can undergo all these conditions of handling, and still be laid in the trench for the smallest size at 3 and a fraction cents per pound, and for the large size—36 inch—for 1.89 cents per pound.

Questioned by Mr. Greene.

There is a saving through the use of trenching machines over ordinary hand labor. It is pretty hard to estimate the amount of saving, because in the Sacramento work, whenever they came to a crossing, they had to stop the trenching machine and do that by hand 4815
labor. The job is not completed yet, and it is impossible for me to tell as to how large a proportion of the excavations can be made by the trenching machine.

Mr. Hazen: I should like to give my general views on the Sacramento and San Diego data: There are too many pipe shops in California, and there is not business enough to go around. The state of the local market with respect to that, and to other conditions, is much what we had in the East in the 90's, when I began my professional work. The first few years of my experience were in hard times, and on a falling market. Generally speaking, every piece of work was done for less money than its predecessor, and we kept cutting our estimates down and down following the cost. About 1897 I was making estimates for quite a number of pieces of work, and in 1898 it was decided to build two of them. The work was started, and just about that time the hard times were over. The prices rose, and one piece of work for which I had made estimates was carried out at a cost of more than 50% in excess of my estimate; another large piece of work was hung up entirely because the advance was so much above my 4816
estimates. It was finally carried out by another engineer some years later at about double the price I had estimated. My estimates had been sound as based upon the data I had at the time, but I had not taken into account the fact that they were based on hard times conditions, on a falling market, on an excess of capacity, and on undue competition.

I recognize that it is possible to get from the records since 1913 very low prices for pipe in California. On the other hand, if you go back a few years to the earlier period that is covered by the rate suit, and to a time when business was not suppressed, you will find prices that are a great deal higher than those that I have used. You can support just as good a schedule on that basis as you can on the other. For this purpose I do not think it is fair to take the low prices, or to take the high prices. You have to look at them all. There has been at least a two to one range between the high ones and the low ones, and it is a matter of judgment where the fair price would come.

I have estimated it just as fairly as I can, and I recognize perfectly that you can go out and get local quotations that go away under my figures. I do not know that there were any less number of pipe houses in the State in 1913 than there are now. I do not think that immediately following 1907 there was a period of industrial depression.
4817 1907 was a year of very high prices, and in 1908 there was a falling off. I do not think that there has every been a revival since 1907 in prices to the same heights to which they were in the years immediately preceding that. From 1909 to 1912 business was fair, but we did not have the highest prices. In 1913 new construction commenced to fall off very rapidly. Of course, prices did not drop at once, but the beginning of the drop was in 1913.

(Counsel for Defendants advised that he had made some investigation in the last few days on the matter of weights, and that all the data he could gather as to weights of Spring Valley pipes did not
4818 agree with Mr. Lawrence's weights, and in view of this fact, he did not feel justified in agreeing for the City as to the weights taken from Mr. Lawrence's records. The only thing for the City to do is to stand by the inventory until something more satisfactory is shown).

4819 Mr. Hazen: Mr. Dockweiler's calculation for lead, and also the figures for the pipe, are all correct mathematical calculations for the geometric quantities shown by the drawings that were made to do this work by before the work was done. I am glad to say that the calculations were absolutely correct, but there was no allowance for loss and
4820 waste, and the plans made in advance did not take into account all the contingencies that would be met; they did not provide any clearance between the bell and the nipple. The work could not be built that way, and as a matter of fact, was not built that way. The Risdon Iron Works had to give considerable clearance between the nipple and the bell in order that the work would go together in a practical way, which resulted in an increase in lead, and in metal. Mr. Dockweiler did not take that into account, and it is very natural that he did not. I agreed with Mr. Dockweiler on the lead. So far as the rest of the quantities are concerned, in making an estimate for this work, I did what I always do, as far as I can, I checked the quantities. If the work were to be done under a specification that called for less material than would fairly do it, you could not expect to get any lower weights; anyone who was doing the work would figure on all the material that was to be used. I considered the matter broadly, the cost of other lines per foot in more or less similar conditions is better evidence to my mind than the detail made up of the items that went into the schedule. Any variation like this in the schedule would not make any difference
4821 in my estimate. Mr. Dockweiler and I split the difference on the lead.

The Master: I will substitute this new sheet in place of the sheet marked "98m". This will make a change in the totals under the two columns of 22 inch and 16 inch, from 262,500 and 166,200 to 259,200

and 164,300; and a change in the cost per foot, respectively, from $19.30 and $12.20 to $19.06 and $12.10.

Mr. Metcalf: I can give you an approximate comparison of the figures with reference to buildings: The gross figures were as follows: Mr. Dillman $198,000; Mr. Dockweiler $136,000; the average of those two is $167,000. Our estimate is $170,000. The net, after deducting depreciation, is as follows: Mr. Dillman $114,000; Mr. Dockweiler $69,000, the average of those is $91,000. Ours is $135,000. The difference between the average of the City's two engineers on the gross, and ours, is only $3,000; on the net it was $44,000. 4822

(Discussion in re. agreement in matter of valuation of buildings). 4822-4824

Witness: Geo. L. Dillman for Defendants. Dillman

DIRECT EXAMINATION BY MR. SEARLS. 4825

The first submarine pipe that I knew of and saw during construction, was the first Bull Run pipe line, at Portland. The second pipe line I knew of but did not see during construction. That was under Mr. D. D. Clark, with whom I discussed the question. I was invited by the Risdon people to go down and see the Ravenswood pipe line put in, but did not get there. However, in talking with Mr. Bassett and Mr. Field, who were active in the work, I knew what was going on at that time, and in a general way I have some notions of the cost of putting in such structures. Except for some variation in getting ready and moving away from the place, the cost of such a pipe line will vary almost exactly as the square of the diameter, other things being equal; and the item itself being not a very large one, and being connected with the main pipe line, I have not gone into the detail that Mr. Hazen and Mr. Dockweiler have, nor do I consider that they are essential to the getting at of a price which a contractor would be willing to contract the work for. I believe that my prices here can be placed in a contract with a responsible contractor, and the work finished at that price. Since coming here this morning I have noticed that according to Mr. Hazen's estimate, the work complete on the 22 inch pipe line, will cost 10½ cents a pound, which, for structural material, will build a very good pumping plant with much more machine work and expensive work and hand work than there is in this structure. In the 16 inch pipe line the estimate amounts to nearly 14 cents a pound, and that will build a very high-class pumping plant, with a great deal of brass and bronze, which is much more expensive material than this is, and all this makes me feel perfectly satisfied with my price of $7.50 a foot for the 16 inch pipe line, and $13.50 a foot for the 22 inch pipe line. Also, I understood at the time that there was an enormous profit made on that particular job. 4826

Witness: ALLEN HAZEN, for Plaintiff.

CROSS EXAMINATION BY MR. SEARLS.

The submarine pipe under the Connecticut River was not my first
4827 one, but was the largest one that I laid. It was two lines of 30 inch, and was about 1,150 feet in length. The Spring Valley was 6,800 feet, being in two parts. The 13,564 feet shown in the schedule is for twin lines, each 6,800 feet. The Connecticut River pipe was not done in the same way as the Spring Valley pipe. It was done by contract, and we used barges, tugs, and a great deal of marine equipment. We had no tidal currents to contend with on the Connecticut River, and most of the work was done at low-water stage, so that the water was not as deep, and the conditions of the current were very much easier; however, we had to do things that were not done in this case. The Connecticut River is a navigable stream, and we had to do some dredg-
4828 ing, which added quite materially to the cost of the work, to put the pipe down at certain depths that were required so that it would not interfere with present or prospective navigation. The depth of water was not very great, which is a very important matter in the case of submarine pipe work, as the cost increases very rapidly with the depth, especially the depth above 30 feet. I have an idea that the contractor made nothing on the job. My figure for that was $39.90 a foot for each line. That was steel pipe, as is also the Spring Valley line.

The crossing at Superior, Wis., is a pipe that I have been respon-
4829 sible for as an engineer of the company for a great many years, but I did not lay it. It was laid by Mr. Ward, who was the inventor of this system that is used. In the Connecticut case I was engineer for the City of Springfield, and designed the method of laying. I designed the whole system. The Superior crossing is approximately 4,000 feet, and was originally laid in water ranging from 10 feet or less deep, up to perhaps 25 feet; since I have been responsible for it, we have had to lower it on account of the improvements in the harbor, and the increase in navigation, and it has also been broken by ship's anchors, and I have had to repair it, and I have had it examined repeatedly by divers, and have sat for days with a telephone bonnet over my head, talking with the diver who was working on it. I cannot give you the exact date when that pipe was laid, but I should say probably in the early nineties. It is constructed with the same kind of joint as the Spring Valley pipe, but there is no steel. The whole length is cast-iron. The 18 inch cast-iron pipe at Vancouver, which I saw recently, cost about $12 per foot for the pipe alone, which I think is quite a little more than what I have estimated in proportion for the material in these lines, and it might be the same in the case of the Superior
4830 pipe. I do not know that there would be any fixed rule on that. It would be a matter of design, and of what was required in each case. I think probably it was necessary to dredge when the Superior pipe was originally laid. I never knew what the Superior pipe cost.

On the Portland work the pipe was laid across the Willamette River, and I think in a general way the conditions were similar to those at Superior. When the first pipes were laid the channel was comparatively narrow, and they laid the pipe that was not in the way of navigation at that time. Afterwards the channel was widened and deepened, and that was one reason why added pipe was required, and additional lines were laid. I have no personal knowledge of whether they dredged when they first laid these Portland pipes, but I think there was dredging included in each case. That pipe line was about 2,000 feet in each case, and I understood they were laid from barges by the Ward method, which is the same method that was used in the Spring Valley laying. To some extent you would have to have the same equipment to lay a short section of submarine pipe as you would have to have to lay a considerably longer section. A long line would 4831
justify somewhat more elaborate preparation and better equipment than a short line. The depth of water is a very important matter in the cost of submarine work, and the equipment varies a good deal with the depth of water and the tidal currents. That is why data for intake work is not applicable for discussing submarine cost of work. We have a great many records of cost of laying intakes in the Great Lakes, which is not applicable to this work, and ought not to be used.

For the last Portland line I segregated the data which I had obtained from the total cost of the work. There were about 4,000 feet of pipe laid—this is from memory—and about 2,000 feet were on land, and the balance under the river, and the items relating to the two parts of work were stated so that they could be separated without any difficulty, and then there were some general expenses that were not separated, and there was no basis for separating, and I distributed those according to my judgment, and told you that it was an approximate separation. A detailed statement as to the cost of that is printed in Mr. Clark's paper in the proceedings of the American Society, and that is the source from which I derived my information. The last 4832
Portland pipe laid was of steel, but I do not remember whether it was of the same thickness as the Spring Valley. That is not a very important item, because the cost of the operation of laying is the most important element in these cases; laying submarine pipe is what is considered extra-hazardous work. It is work that cannot be scheduled in the way that work can be scheduled that you can get at, because it is a matter of experience that so many things happen in carrying out the work that they cannot be anticipated, and the work has to be done over so often because it leaks, that it is mainly this element that makes it cost more relatively than one without experience would anticipate it was going to cost. The Spring Valley pipes were not laid over; they seem to have been very fortunate in that respect. On a job like that I think that a contractor has to figure on a pretty high percentage of profit. If he is exceedingly fortunate in his judgment as to condi-

tions, and gets through without any delays or accidents, he expects
4833 to make, and ought to make, a much higher rate of profit than he would on work that did not involve that risk. On the other hand, under conditions that are very apt to happen, he will have to meet a great many payments that he did not anticipate, and could not anticipate, and it will frequently happen that a contractor won't make anything.

In 1913: I think probably at that time contracts for ordinary pipe laying were being made at a pretty low rate of profit.

Questioned by Mr. McCutchen.

4834 In laying pipe as these were laid, the joints are made on the boat, and then the pipe is paid out, and it cannot be paid out just as rope; it has to be supported on the way down, and the harness for supporting it is a very important part of the operation. If the greatest depth of water is about 30 feet, as was the case at Springfield, Portland, and Superior, the comparatively simple tackle will serve, while if it has to go down in 50 or 60 feet of water the harness for handling the pipe is very much more of an institution, and it is particularly for that reason that it very often happens that things have to be done to these pipes by divers after they are in position, and whenever that happens, the cost of diver work increases very rapidly indeed with the depth. Also, as they work for shorter hours at the increased depth, I suppose in a general way the cost of doing work in 60 feet of water is perhaps four times what it is in 30 feet of water.

Questioned by Master.

The tidal currents at Ravenswood were very strong, and caused a great deal of difficulty in anchoring equipment so that it would not be misplaced by the tidal currents. The depth of water, as I re-
4835 member, was about 50 feet at low water.

Questioned by Mr. Searls.

I understood that they did not do any diver work on that job, but they were very fortunate in that. I think no contractor would be warranted in taking work of that sort without the expectation of probably having to use diver work in finishing it up. In figuring the cost of reproducing this element of the system I assumed that a man would have to know his business very well indeed to do it at these prices that I have used. I do not think a contractor would be justified in bidding for a piece of work of this kind, unless he expected to make more than 20%, but if he did bid on a good many pieces of work, he would not realize his expectations except on a small part of them; how much he would actually make on an average, is something that I would not attempt to estimate. I have made a great many
4836 estimates, and I do not remember that I have ever taken as one element of the estimate what the contractor's profit would be. My basis has been to find what was the normal ordinary cost of doing work of this kind, including the profit, which is presumably a fair, normal

profit. My figures as to the submarine pipes represent my judgment as to what the work would cost per foot, which is an amount including, and intended to include a fair profit. It rests to some extent on the analysis of the materials that enter into this particular line, and to some extent on information and experience with other lines. Taking my figures as to the cost of laying, you might say, if you like, that when I came to that I simply said, "Well, I think it would cost about that much, as a result of my experience". I took particularly into account the experience of the Spring Valley Water Co. in laying this 22 inch pipe in that connection, which I considered very low. If it had not been for that, if I had been dependent upon what I had learned from seeing similar work elsewhere, if these lines had not existed, I am very sure that I should not have reached a figure for that item quite as low as the one I have used. In the light of all the information, including what was done, this is my best judgment of what you would get a contractor to do it for; if this particular crossing had not been made, if Ravenswood Straits was just as nature made 4837
it, and I was estimating for a client what it would cost to lay these lines across, I should advise him somewhat more than this figure, but taking into account what actually happened, and the fortunate experience of the contractor, I have made the figure which I have. If I had known that a very large profit was made on this job, I should have taken that into account to some extent. I understand that the contractors handled this work very skillfully, and had very little trouble with unexpected conditions that have been so common on contracts of this kind. If the history of Eastern work was to be brought into account, which I did not intend to do, not because I did not have any, but because I had a few Pacific Coast cases which I have thought you preferred, you will find a long line of these people who have undertaken to do these things, and have not been able to do them, and people who have had the work done and it has leaked, and has not been successful; in this case the Risdon Iron Works not only built this pipe, but they guaranteed it, and 25% of their money was not paid until the tightness of the pipe had been demonstrated to the satisfaction of Mr. Schussler. If there had been a leak in these pipes when they concluded all the work, they would have had to gone out at their own expense and taken these pipes up and laid them over again. It is very hard to repair these pipes when they leak. and it 4838
would involve a very large expense under the most favorable circumstances.

The Vancouver job was of cast-iron pipe. The pipe was 18 inches in diameter, so that it is a very good comparison with the Spring Valley pipe. The material at Vancouver, not including the cost of laying it, was about $12 per foot, and steel would not differ very widely from that; it would be possible to interpolate between those two estimates and get a comparable figure. I suppose Spring Valley used steel be- 4839

cause it was cheaper, and because Mr. Schussler, perhaps, thought it was stronger and more desirable in case of earthquake shocks, and I have no doubt that in Vancouver they used the cast-iron because they thought it was cheaper than the steel, and they are not afraid of earthquake shocks. That is just my surmise.

Mr. Metcalf: One of the lines of pipe at Vancouver is 1,250 feet, which is the one we examined, and the depth of water was between 50 and 60 feet, and they made their joints in about 40 feet of water, if I remember rightly, at low-tide.

Mr. Hazen: They did not use the same method of laying the pipe as is used here. Instead of handling it from a barge, there was a flat shore on the far side of the crossing in each case, and they built a runway on that shore which was a continuation of the line, and put the pipe all together on that runway, and then they put very heavy steel wire cables on either side, and put that under tension, and clamped
4840 it to the pipe, and hauled the pipe across on that cable; the cable goes clear across to an enormous windlass on the other side, and they drew it in that way. It is a method that could not be used with a wider crossing; in fact, they have had a great deal of difficulty carrying it out with the crossing of the width that actually exists at Vancouver. It is impossible to make a strict comparison of the cost of laying that pipe with the cost down here, because no two things of this sort are entirely comparable, but in a broad way it is comparable. I should say that the labor conditions were just about a stand-off, and I do not know why there should be any difference in overhead. The Unions are undoubtedly strong in the Canadian Northwest, but how far they
4841 control prices of labor, I do not know. I do not remember in what season of the year the Spring Valley pipe was laid. Mr. Lawrence told me that there was a bad storm during the laying of it, and the fact that they did not have any accidents would tend to lead me to believe that they were pretty good contractors, and that history might possibly repeat itself in a reproduction. I do not think that would have much bearing on it, however.

Metcalf

Witness: LEONARD METCALF for Plaintiff.

4842 DIRECT EXAMINATION BY MR. GREENE.

These are largely cast-iron pipes, and consisted of three lines across the Concord River, laid in the year 1899; also one across the Kennebec River, 800 feet long, laid in 1904; one on the China Lake Supply, at Waterville, which was laid in the same year, 558 feet long. The first ones were at Concord, Mass., under the Concord River, a sluggish stream with a very muddy bottom; the first one in 8 feet depth of water, 8 inch cast-iron pipe, 155 feet long. The contract price for laying was $6 per foot, and the actual cost furnished

and laid was $7.58 or more. On the Nashawtuc bridge crossing, where there were similar conditions, with 6 to 8 feet of water, 125 feet long, the contract price for laying was $6 per lineal foot; the actual cost furnished and laid was at least $8.15. These were both laid in the year 1899. Those prices include the material. One across 4843
the Meadows, which was on a sandy bottom; in that case a 12 inch cast-iron pipe, 141 feet long, depth of water being about 4 to 5 feet, the contract price was $6; the actual cost furnished and laid was $5.45. In this region cast-iron pipe is worth about $25 a ton delivered, on an average of a ten years period. The Kennebec River crossing was 800 feet long, 20 inch cast-iron pipe, with flexible joints every third joint—this is not wholly comparable because of the character of the bottom, which was firm; enough material was dredged to cover all the pipe the depth of 1 or 2 feet with an orange peel dredge working from a double line of piles. The contract price on piles
that was $3.20 per lineal foot for the pipe, and the laying cost was $6.50, a total of $9.70. The cost of laying was approximately $4.12 per lineal foot, as against the contract price of $6.50; in addition to that there was a break, and two joints had to be repaired under freezing conditions, and those cost the contractor almost exactly $2,000.

On the Messalouskee River crossing, in 1904, 319 feet of 20 inch cast-iron pipe, the laying contract cost was $6.50, the pipe $2.14, or a total of $8.64. The estimated actual cost to the contractor was $2.14, and laying $4.77, making $6.91. The so-called Shoddy Hollow crossing, of 245 feet, of 24 inch cast-iron pipe, contract price $6.99, actual cost $7.54. The Bayou crossing of 112 feet of 24 inch pipe, contract price $7.40, the estimated cost to the contractor $6.67. The Davis Mill crossing, 67 feet long, contract price $6.65, cost $10.55. The Sewards Mill crossing, 270 feet, contract price $6.81, actual cost 4844
$17.80. In 1905, on the Kennebec Water District work, the Sebasticook River crossing of 260 feet of 10 inch cast-iron pipe, laid on rocky bottom, contract price with 8 to 12 feet of water was $12.50; the contractor was fortunate there in having exceedingly low water in the river, and the cost to him was estimated at $5.76 on the laying only, the pipe being $1.43 in addition to that. It was about one-half the contract cost, owing to fortuitous circumstances, and unusual conditions. There is one other on the intake of the China Lake, 558 feet of 24 inch pipe, contract price $19.02, the laying alone being $15.80. Owing to delay in the work, the contractor had to remove the line of piling, and his derrick after the ice was out of the lake, and so it cost him $32 a foot. The sewer outfall of New Bedford, which I think is somewhat comparable to this, is on the point running out to Buzzards Bay from the city, a muddy bottom; tugs were used in the same way, with comparatively very little diver work. The cost of the dredging was $14,000; this was 16 inch pipe

with flexible joints; the laying was $52,600, the laying of the outlet $2,000, making a total of $68,900, without the cost of the pipe which was $44,000 more, making a total cost of $34.50, of which about 40% was for the laying alone. In all of these first figures which I have given the work was done without a dam, and in some of the shallow
4845 cases simply using a sand bag dam and a trough to carry the stream over in the narrower crossing; in the river crossings they were shallow work, and in none of them was a dredge used, nor did the work involve the submarine apparatus to the extent that it was used in this case. I believe these figures to be on work of a character very much less exacting and less expensive. These pipes were laid under my direction, and we designed and supervised the construction of the work.

4846 CROSS EXAMINATION BY MR. SEARLS.

I think in the majority of examples that I had the figures referring to intakes are reliable as an index to the cost of submarine work, but as a general rule, I think it is true that the figures referring to intakes are not very reliable. I was in charge of these crossings. We made the plans in our office, under my direction. One of my junior partners was resident engineer on the work, and I visited it twice a month. The Kennebec Water District work,
4847 and the Concord sewerage work were done by contract. The 60 inch outfall sewer at New Bedford was in Buzzards Bay, and was different from the river crossings in that we did not have two banks to work from, but in other respects it was similar. It was done from scows; it was dropped, and the joints were finally inspected by divers. The charge for dredging of $14,300 was a comparatively small item out of the total of $113,000, being only about 10%.

Referring to the job on Chelsea Creek in 1900, a 24 inch pipe: I do not think the method of laying that pipe was similar to the method used in the Spring Valley system, though I am not very familiar with the details of that. It is my recollection that that was built where the water was not deep, being somewhat in the nature of mud flats, with a maximum depth of 25 feet at low water. The $8.25 per foot was the cost of the laying—removing the other pipe and laying that one. These were fairly short lengths, for the most
4848 part, as compared with Spring Valley. From my recollection of the place where the pipe was laid, I should say it required less equipment to lay the pipe in Chelsea Creek than was needed for the Spring Valley job. The depth there is considerably less. The tidal prism is less, and consequently the velocities to be dealt with are less, and I think that the exposure to wind that would give wave action and trouble on that account is very much less. The methods used in laying pipe in 10 feet or less of water would vary materially from those used in laying pipe in deep water; they would be less expensive.

Mr. Hazen: I have laid pipe under water on other occasions 4849
than the Springfield job, and I have had to do with old submerged crossings very frequently, and have had occasion to look up their histories, and find out what they cost, but I have not any detailed memoranda of those here at the present time.

Witness: GEO. L. DILLMAN for Defendants. Dillman

CROSS EXAMINATION BY MR. GREENE. 4850

I have never laid any submerged pipe myself, but I saw a little of the work done on the first Bull Run pipe crossing the Willamette River, at Portland. I was not in any way interested in the laying of that pipe, and have not the details of the costs that were incurred. The reason for my price is primarily the belief that I could induce a reliable contractor to take the job at these prices. It is also comparable with the last price of the Willamette crossing, at Portland, but I do not now know the cost of that pipe. I simply said, from a 4851
rule of my own, that it would cost to lay any pipe of this kind in proportion to the square of the diameter of the pipe. A great many years ago I quit trying to take the data of one job to apply it directly to another, so I have not kept for a great many years exact data of what I was doing, and yet, in a very general way, I have distinct impressions as to what certain work costs. The reasoning back of that formula would be that the weight of the metal would be approximately as the square of the diameter, and the cost of laying would be in about the same proportion; that is, if you double the diameter 4852
of the pipe, it would cost you about 4 times as much to lay it. It is not exactly a hard and fast formula, nor is there such a formula possible, but approximately that is the basis of my opinion on the price, and it is based upon what experience I have had, and what observation I have used, but it is not based upon definite data, nor is such a formula possible. It is a formula nearer right than any other exponent that I could name now. It is certainly nearer right than three, and it is nearer right than one, as an exponent and I have taken it as two. There is so much difference in cost, due to management, specification requirements, and inspection, that no rule of that kind taken from one job will apply directly to another.

Take for instance the 16 inch pipe laid for $9.50; if that were reduced to 8 inch, the formula would divide that cost by 4, and if the pipe were 4 inches, you would again divide it by 4. Of course, there are limits to the application of any formula of that kind. Any interpolation is not so bad, but exterpolation might lead to some very grave errors. An 8 inch pipe would probably be much heavier in 4853
proportion than a 16 inch pipe; if it were in the same proportion as to weight, I think it could be laid from Dumbarton to Ravenswood

for $2 a foot. I would not use this method of laying a light pipe of that kind. I think I would lay it with a cable and floats, but that is a matter that would require a great deal of study and detail to get at. In connection with my appraisal, I just went over the line at Ravenswood, and saw what was exposed there, and only examined the pipe where it was exposed at low tide. I did not go on to the flat. I think I saw that from the bridge. I saw the pipe that is submerged at high-tide, but perfectly visible for a number of hundred
4854 yards at low-tide, and it seemed to be in very good condition; I could see from the bridge that it had a good many barnacles or shell fish on it. Those pipes are a distance of from 800 or 1,000 feet from the bridge.

In reaching my figures of $7.50 and $13.50, I did not attempt to make any segregation as to the cost of the laying. Those figures were close enough for the purposes of this kind of an estimate. If it was submerged pipe without connection with any other pipe line, I would probably have gone into it more carefully, but this was sufficient for my purposes, and was close enough to what I wanted. The estimate is a very good estimate for the whole contract, and by
4855 "the whole contract", I mean the reproduction of this Alameda Pipe Line, taken as an entity.

If I had had this problem all by itself, from all that I have heard of handling the marine equipment there, I do not think I would have paid much attention to what they did. I was a sailor before I was an engineer, and I think I understand something more about handling barges than I have heard was used in the handling of that equipment. I do not think I would have been hampered by any storm in prosecuting that work, because I think I could have taken sufficient precautions. In determining that cost more carefully, I might have gone into details, but I doubt if I would have gotten any
4856 more satisfactory results by doing so. It might possibly have been as satisfactory.

All I have in the matter of submerged pipe, and in the matter of a great deal of other work, are impressions gained from the experience that I have had. I have not had very much experience in the matter of submerged pipe. I have not laid any, nor had any experience in connection with the actual laying of any. The exact point in which I have gained information is very frequently entirely lost to me, and it is lost in this case, except as I have stated. I stated I knew approximately the cost of the second Bull Run pipe line, and I think that is the basis of this estimate. I had Mr. Clark's information at the time I made this estimate, but I did not have any
4857 other information as recent as that. I had the figures on this pipe at the time it was laid, but I did not use them. There were other figures that I have read from time to time, and believed, besides the second Bull Run pipe line at Portland, but I do not know to what

extent they were used. They were just the various descriptions I have read in the technical papers, and I do not remember what lines they were.

RE-DIRECT EXAMINATION BY MR. SEARLS.

Costs on other jobs are not directly applicable without modification. They go to make up the sum total of a man's experience in costs. I use costs as a means of ripening my judgment, without keeping any track of them, or filing them away. 4858

Witness: J. H. Dockweiler for Defendants. Dockweiler

CROSS EXAMINATION BY MR. GREENE.

I laid 1200 feet of 24 inch cast-iron pipe out into the ocean, which was the outfall of the sewer in Los Angeles, and was laid in 1893. I think part of it was a flange joint, and part of it was the ordinary ball and socket joint. I do not think we got in over about 15 feet of water at the end, and I think there was 600 feet submerged. It was cast-iron pipe, and the joints were made on shore, and as each joint was fitted up the pipe was slid out into the ocean. I do not consider it comparable to submerged pipe at Ravenswood, because it was laid entirely different, and to meet entirely different contingencies. I do not remember the cost. I have laid no other submerged pipe, but I have read up the literature on the subject pretty well at the time of the first Spring Valley appraisal in 1904 and 1905. I have never actually seen any laid, but I have seen photographs of the actual laying. The basis for my valuation here is my investigation of the description of the laying of this pipe, as contained in the published reports of it, by Mr. Schussler; the records of the company; the time consumed in laying, and the equipment; the equipment is set forth graphically by charts and drawings in a publication by Mr. Schussler. I also read an account of the laying of this pipe, by Mr. Robert Moore, who was connected with the Risdon Iron Works at the time of its laying. I had a conversation with one of the assistant engineers who was on the work of laying it. I had a talk with Mr. Dorward a day or so ago, who laid the pipe for the Risdon people. At the time I was making this estimate, I remember he told me, in answer to a question, that I could at the present time lay that pipe, or contract to have it laid, for the price paid by the Spring Valley Water Co. The article by Mr. Moore was in a publication in file in the Mechanics Institute Library. I think it was published in Edinburgh. I also had a talk with Mr. Cyril Williams, one of the assistant engineers of the Spring Valley Water Co., who was on the 22 inch job a part of the time. 4859 4860 4861

4862 The cost that I figured in laying, profits, insurance, incidentals and contingencies, is 1.71 per foot for the 16 inch, and 2.76 per lineal foot for the 22 inch. That contract price includes everything that I have set forth. The contract includes the cost of the bell and the nipple, of the lead, and of laying. That $10.50 is not for the mere cost of laying. My figure for the 22 inch is $9.33 a foot, and for the 16 inch it is $4. I am taking each one of those as 18 feet
4863 long. The 22 inch pipe is given as 18 foot length.

Mr. Hazen: 18 times 700 does not multiply up to the length of the crossing.

Mr. Dockweiler: I remember taking the 18 foot length at the time with Mr. Barnes who represented Mr. Metcalf; I remember we had quite a time in getting this inventory. I know the figures I have used are the ones we agreed to at the time this inventory was
4864 made. My 22 inch cost dipped was $73,751.92 without any cost of laying. That included the metal.

The Master: Mr. Hazen's figures are $79,709 for the same matters.

Mr. Dockweiler: I took the cost of the pipe galvanized at 6
4865 cents a pound, but I did not segregate that for the galvanizing. I got the quotation from the Crane Co. already galvanized.

Mr. Greene: As he figured it out on Wednesday, Mr. Hazen was 6 cents, and Mr. Dockweiler was 6 cents on the 22 inch, and 5.6 cents on the 16 inch, including galvanizing.

Mr. Dockweiler: I take 1,177,882 pounds at 6 cents. That is the stipulated weight in the inventory.

Mr. Hazen: I think you are 500 feet short.

Mr. Dockweiler: I do not get that into feet, I take it in pounds, and the inventory shows it in pounds. If you take my same weight of pounds by your price, if you are a little bit lower than I am in the unit, you are bound to be less in the total if it is the same quantity.

Mr. Hazen: The records of the National Tube Works, in Pittsburg, show just what this pipe weighed, and that I took. They paid 1½ cents for galvanizing, and weighed it before it was galvanized,
4865½ and after it was galvanized. We seemed to be wrong about that $9.50 as not including the body of the pipe. It does seem to include it in that case. In that respect it is comparable with the latter case. They did not galvanize the joints with the pipe, and the record is perfectly clear as to that.

Mr. Dockweiler: Then the answer is this: I held to the inventory; you did not.

Mr. Hazen: I think so.

4866 Mr. Dockweiler: I think that it is 6,800 feet across the water, but I am frank to state that I do not go back of the schedule.

CROSS EXAMINATION BY MR. GREENE.

Referring to my figures excluding the dipping: Of the 16 o.d. galvanized, 710,118 pounds, at 5.6 cents per pound, equals $39,766.61. Painting bells 7,950 square feet, at 1.3 cents a sq. foot, equals $103.35. 700 lengths at $75 each equals $52,500. That gives a total of $92,369.96. I will have to divide that by 700 times 18, which will be $7.33 per foot. 4867

The 16 inch pipe was laid in the year 1888, and there was available at that time the experience of John F. Ward, of Philadelphia, who was the originator of this joint. I think the Risdon Iron Works laid the 16 inch pipe. In examining that crossing, you will note that there is a very long part of the flat that is uncovered at low-tide that a man would avail himself of in laying. He would choose a time of the year when things were favorable. The only 4868 difficult job is that portion which goes across the deep part of the channel, which is against the Dumbarton side, or the eastern side of the channel. San Francisco has done a great deal of submarine work in this harbor, and there are firms around the bay who are fully equipped with barges and equipment incidental to work of that kind My position is this: You are reproducing now, and you take conditions as you find them in the same way under my theory. I reproduce a pipe in this city; I find a pavement over it, and there may have been no pavement at the time the pipe was laid. According to my theory, a man to reproduce that has to cut through that pavement, and must replace it. The cutting through that pavement and the replacing of it is part of the cost of reproduction, and in the same way reproducing these lines, the knowledge that is now available was pioneered by the man who laid the first pipe across San 4869 Diego Bay. If you could have kept the knowledge of the original contractor within his bosom, he would not have had any occasion to bid any lower, but if the data had not been open to others, he would have put a monopoly value on the work, and would have bid up to what he thought his clients would stand for. I do not know why Mr. Schussler laid an 8 inch pipe at San Diego, but I should judge he gathered experience and information from that job, but the crew which he brought here from that San Diego job was, I think, only the crew for making the joints. In this Risdon Iron Works contract 4870 the joints were made by Spring Valley employees, and I am satisfied that applies to both jobs. It is pretty hard for me to say whether, if the crew who did the work at San Diego was the crew who did the work up here, it would affect the figures I have reached, so far as the comparative figures of the two jobs are concerned. I cannot disassociate the idea of the knowledge I have gained from the experience of those men. I do not know how I would proceed to make the estimate, if I had not had the knowledge of the cost and the rate of progress of some of these jobs.

If I could avail myself of all that knowledge, those figures would
4871 be lower. If the same gang which had done the same sort of work at San Diego which laid this Spring Valley submarine pipe, and I knew that to be a fact, I would not make any change in my figures, because at the time I made these figures I cannot recall that I had that San Diego job in mind. I did not have it in mind, and I would
4872 not have raised my figures if I had known that to be a fact. I had all that data knowledge before me, and those are the figures I used. I do not know that I can exactly answer as to what part the fact that this was new work played in my appraisal; if I could not have gotten any data upon the subject, I would have taken the company's figures, the laying cost, and state that I am unable to get anything, and that from general knowledge of improvements in the art and experience, the price today would not be any higher than it was then. I would reason on that line, but having had the company's records to some extent before me, I was enabled to shade the cost of laying that pipe. If I had no data, I would have to go on general hypothesis
4873 and take cost, but having had information, I was justified in fixing the figure that I did take.

It was 13 years between the laying of those pipes. They specified 5 inch cable for the last one; now you are doing this job at once, and you can do away with one cable. You have the availability of gasoline launches, and quick moving devices that probably
4874 you did not have in those days. I do not think they had gasoline launches in 1888, and we do know as a matter of fact that improvements have taken place, but just where you can put a specific finger down, and say here, it is pretty hard to state. Assuming the identical method which I have figured on, you know there have been changes made that justify me in the statement that it won't at the outside figure cost any more than it did then, for the reason that profits are not as high now as they were then. The matter of profit alone would help out, and labor would cost more now, and the efficiency of labor, in my opinion, is not as good now. You must note one thing, I allowed 25% on material and labor to cover some incidentals, because my laying force is actually less than what they used. I do not know how many men they actually used. Mr. Williams told me that he thought there were about 20 men off and on in different pieces of work; there were cooks and waiters which I have not included; they had to board those men on the job. I had to
4875 make a figure big enough to cover what would, in my opinion, lay that pipe and provide a fair profit. I think labor cost has increased in the neighborhood of 35% possibly, but that would not offset any improvements that there might have been in the arts since that time. Roughly speaking, it will make a balance.

Referring to the 22 inch pipe: The cost per foot of laying, exclusive of dipping and galvanizing, and the cost of the pipe,

was about $9.35 a foot. That is for 12,600 feet. I am figuring the 4876
total weight, and to make mine comparable with Mr. Hazen's, I must take an additional weight of metal. The fact that profits were a great deal less, and that there are more men in the business available, was what made me adopt a figure of somewhere around $9, as against $10.90, which was the cost actually incurred by the company in laying that pipe. The only people who have laid submarine pipe around the bay, that I know of, are the Risdon people and their 4877
connections. Other people could have gone to other sources of information between 1907 and 1913 and found out how to do it.

The 22 inch pipe was laid between November, 1901, and probably January or February, 1902. The 16 inch pipe was laid in 1888, I do not know the month. The water was turned in on the trial run in about August, 1888, so it must have been laid previous to that time.

I allowed a great deal on account of contingencies to cover the 4878
laying of the 16 inch pipe, as against pipe that would be laid now, but that contingency did not mean simply that physical added burdens at that time as against this; it was to cover my lack of knowledge on the details. The actual laying force that I have provided is smaller than the men who were really engaged on the job. I did not include men who were handling launches, or cooks, roustabouts, and the men they might have on shore. I did not know how many men there were. I made a big allowance to cover those men in addition to my profit. Instead of taking 25% on the labor alone, I took it on labor and material cost. My cost of 8 cents a pound for the bell itself includes all the profit, and the cost of landing it ready to be loaded on the barge. I added a second profit on that as the means I took so as to cover men whom I was informed were on the work, but whose exact number I did not know, and so I made an allowance to cover such men that were on the job. On the 22 inch pipe I figured $15.83 for laying it, and then I allowed $33.58 for profit, contingencies, etc.; there was almost 200%. When I make an estimate that way, and do not know what actually transpired 4879
beforehand, it has to be in the nature of a guess to play safe, and in my opinion, I played safe there.

Questioned by Master.

I fixed that figure arbitrarily. I allow 25% on $134.31, which made $33.58, and I took 25% of my estimated labor cost. For my profit, insurance liability, and incidentals, I allowed 25%.

CROSS EXAMINATION BY MR. GREENE.

I took that 25% on my judgment; that was the best I could do from my knowledge and reading, and everything I could pick up at that time. I did not attempt to get any data on any other submerged pipe work in fortifying myself here, but a year and a half

4880 ago I interviewed Mr. Dorward and his son, and they told me that the job could be done at the price the company paid for it, and with that information from men who knew, I was satisfied that my figures were right. I did not attempt to get any figures from anybody as to what other submerged pipe work had been done for, excepting the figures I got from the people who actually built the Spring Valley pipes.

I am not familiar with the submerged pipe which the City has been endeavoring to put in at Bakers Beach, and that sort of work would not necessarily control. If I had known anything about it, I would have seen the work, but I didn't know anything about the job.

Ellis

Witness: N. RANDALL ELLIS for Defendants.

4882

DIRECT EXAMINATION BY MR. SEARLS.

I am 39 years of age, reside in San Francisco, and am a civil engineer. I have been identified with civil engineering for the past 20 years. In 1894 I started with the Blue Lakes Water Co., who purchased the Stockton Water Co. in 1895. Part of my duties were to compile and analyze operating and construction costs on the water system in Stockton and in the Sierras. In 1896 the company began the construction of a hydro-electric plant in Amador County, and I spent a year on this construction until its completion. It involved flume, ditch, pipe laying, excavation and concrete work, power-house erection, and machinery installation. My particular duties were to keep check on construction costs, and on teaming and distribution of material.

During 1898 and 1899 I was principally engaged in assisting on studies preparatory to the development of the Standard Electric System, and was also purchasing agent for the Standard Electric Co. In 1900 was appointed superintendent of construction for the Standard Electric Co. in the hydraulic department, which handled the construction of two large rock-filled dams, earth and rubble masonry dam work, the building of 20 miles of canal and flume system, tunnels, sawmills, buildings, telephone lines, and the Tabeaud Dam, the latter a large earth dam being contracted. I also had supervision over the teaming outfit and general construction offices,
4883 boarding houses and commissaries. This work involved the expenditure of about a million dollars, and I spent 4 years on it. In 1905 was manager of the Humboldt Construction Co., in Humboldt County, on electric railway work, and the installation of a power plant and wharf for the Humboldt Transit Co. Expended about $150,000. In 1906-1907 was assistant to F. S. Edinger, Chief Engineer of the Shattuck, Edinger Construction Co. We were handling

heavy steam shovel work on the Santa Cruz-Davenport line, and building bridges for the Western Pacific and Northern Electric Railways. My duties were in the field inspecting progress on our various contracts. In 1907 I became engineer for the contractors on the Market Street sewer system in San Francisco; about 6,800 feet of sewer, and an expenditure of $115,000 involved. In 1908 was superintendent of construction for the Crocker Estate Co. on the subdivision of the first Crocker Tract, now part of Daly City. This work involved grading, steel work, sewer trenching, quarrying, gutters, and the installation of the water pipe.

The latter part of 1908 I went to Los Angeles as manager for D. J. Desmond. The company took contracts in Arizona and Lower California, for railroad work involving $175,000 to $200,000, and also had the contract for the boarding houses and commissaries on the Los Angeles aqueduct. My duties took me over the line of the aqueduct frequently, and I had a good opportunity to observe their construction operations, and we were furnished monthly with the cost analysis of direct labor charges on the aqueduct. In 1910 I became 4884
assistant engineer on the Los Angeles Highway Commission, who were building a $3,000,000 road system. My duties were practically office engineer, and I had charge of the cost department, accounting department, construction department, the handling of material, and purchasing department. My office also handled the compilation of operations and costs at one quarry, and the progress reports and estimates on all construction. In November, 1911, I returned to San Francisco, and was engaged for a short time with the J. G. White Co. on the preparation of the inventory for the Spring Valley Water Co. I then was appointed engineer for the Finance Committee of the Board of Supervisors to make a study of costs and methods in the department of street repair, street cleaning, sewers and buildings. On completion of this work in 1913, I became valuation engineer for the City Attorney's office, and since that time I have been engaged in studies of the gas, electricity, telephone and water systems.

Since 1913 I have given testimony by affidavit in both the gas and the electric cases, and I have been on the stand before the Railroad Commission a number of times to give testimony on the construction cost in hydro-electric development. Keeping account of 4885
the cost of work has been rather a hobby with me from the start, and as I took hold of construction I always kept it up, and as Superintendent of Construction, I have had an opportunity to obtain full costs and detailed cost. As a result of this experience I have become familiar with the cost of trench excavation in northern and central California, as practically all the construction I have handled involved more or less pick and shovel work, trenching and ditching; I have had numerous trenches of various sizes to dig in connection with pipe lines.

I made an examination at your request, of the character of material which must have been excavated in the construction of the Spring Valley lines in the district outside of San Francisco. I was slightly familiar with the general character of material from a knowledge of some of the Spring Valley lines, and I spent all day Friday and Saturday morning on the pipe lines, noticing the char-
4886 acter of the material. I followed the route of the various pipe lines in San Mateo and Alameda Counties. I am familiar with the prices of labor, and the cost of doing work in the bay section of that character, in the year 1913. I figured that the average excavation, covering all contingencies, would be 70 cents a cubic yard; that includes backfilling, and also would take care of the difficulties encountered along the state highway, exclusive of any pavement replacement. This includes the trenching and backfilling work of the complainant outside of the city only.

I selected two or three similar jobs as being representative of certain classes of excavation with which I am personally familiar. The Argonaut pipe line that we built has an inverted syphon which is in hard clay in the Sierras; the trench was practically 3 feet wide, and 4 feet deep, and work cost us at that time for excavation and
4887 backfilling 38.4 cents per yard. Our labor schedule in those days was $2.25 for 10 hours. That work resolved into present labor conditions would represent about 45 cents a cubic yard. The Sutter Creek syphon, which is another one in the Sierras was in a mixture of clay and slate, such as appears in certain sections of the Spring Valley line; the total cost on that, including foreman, was 47 cents. Under the present wage schedule it would be about 56 cents. For sand work and lighter work I did considerable excavation in the Crocker Tract in Daly City in the northern end of San Mateo County; my trenches averaged from 6 to 7 feet, the cost of excavation was 15½ cents per cubic yard, and for backfill 3.2, exclusive of foremen, or a total of 18.7 cents. Including foremen and general utility the average would be 23 cents per cubic yard for excavation and back filling. That was in 1908, and we were paying the majority of our common labor $2 for 9 hours—some of them $2.25. My average labor rate on that work was 23 cents an hour, and I figure on the present schedule that that same work would cost practically 28 cents. I simply cite this as being indicative of a certain range of that class of work. I take into consideration in estimating the Spring Valley work more the general sizing up of the situation from about what I figured could be accomplished according to my experience over a wide range of trench work, and work similar in character.

I did not figure a trench machine as part of these figures. I
4888 have never handled a trenching machine personally, but I am slightly familiar with its operation, and have seen their costs. I figure the costs largely on the basis of hand work. My examinations

of the Spring Valley pipe line were sufficient to satisfy me as to the character of the material in which the work would be done. I have reflected the state highway work into the total. Roughly, with the elimination of the state highway work, I would figure the total, instead of 70 cents, possibly about 65 cents; that is, if there were not added difficulties through this stretch.

Witness: DAVID DORWARD for Defendants. Dorward

DIRECT EXAMINATION BY MR. SEARLS. 4889

My home is in Alameda, my business is in San Francisco. I am 66 years of age, and am a consulting and contracting engineer, associated with the Dorward Engineering Co. We represent Petroleum Iron Works Co., of Sharon, Penn., one of the largest steel fabricating companies in the country. I am not familiar with the work done by that company in Pennsylvania unless they keep us posted. They keep us posted on what is being done out here, and our costs out here are generally compared with the costs back there. I was manager of the Risdon Iron Works prior to the time that I became associated with this firm, and I was with them 36 years in various positions, 4890 and had charge of their work for possibly ten years as manager. I had a great deal to do with making up estimates of the cost of the work, and that company did a great deal of pipe construction and laying. They were very well equipped to handle large pipe jobs. While I was manager of the company, they did lots of work for the Spring Valley Water Co. We handled a 30 inch pipe line ¼ inch thick; then the 44 inch came along, No. 6 and No. 9 thick. Then the old 36 inch pipe line and the 54 inch. Then we had the submarine pipes. We got the plates from the east by rail, and we sheared them, punched them, rolled them, riveted them, and shipped them out as pipe. We had nothing to do with the dipping of them or the transporting of them. The Spring Valley furnished the most of the plates. The Risdon Iron Works went out of business in 1911, but since the iron works went out of business I have kept in pretty close touch 4891 with the pipe manufacturing on this coast. I am familiar with the cost of fabricating, and also of laying, calking, and riveting in the trench. I prepared a table at your request, showing the cost of fabricating and laying the original Spring Valley pipes, which were constructed and laid by the Risdon Iron Works. I had charge of the work, and had an accurate account of the number of men employed, wages paid, and the number of men used each day on a certain class of pipe; we knew how much work they could do in a day, and from that we got the cost per foot. I have no accurate table, but I have notes from which I made up that table.

4892 Questioned by Mr. Greene.

Mr. Moore was the general superintendent of the Risdon Iron Works, and I was the shop manager. I have never had any memoranda showing the actual costs to the company on their books, and never had an opportunity to see those, but we had the costs of the work actually done. I had the number of men who were employed at a given time, and the number of hours they worked. My memoranda is copied from actual data that I took in the shop, but I do not know actually what the cost to the company was for any of
4893 these pipe lines on the books. I know the rates of wages that were paid men during the time that they were in my employ, as I set the rate of wages for them.

Questioned by Mr. Searls.

The men worked 10 hours per day up to 1902, and so many men turned out so much work in that time, and that is what we based the cost on. We usually added 50% for overhead cost, which was the standard practice of the shop at that time; it was increased afterwards. The way we took it was that we could do so much work per day. So many men could roll so many sheets per day, and they
4894 could punch so many sheets per day. To work up from that the amount of pipe that was made would take an expert. In preparing this data from my notes, I took the average amount of work done per day in punching sheets; the number of sheets rolled; there were so many sheets to the pipe. Also the number of seams that could be riveted per day. That constituted the number of feet of pipe that was made per day. Then I added 50% overhead, and that made the cost. What I have here is not a cost taken from the company's books, but is just such an estimate as I would have figured at that time if the job had been handed to me to bid upon. A good deal
4895 of this data was taken from actual jobs on the Spring Valley pipe. I saw the specifications of the Spring Valley Water Co. for the fabrication and laying of its pipe, but in making up this table of costs I paid no attention to them. When I made up the table of costs, I
4896 considered the length of time it would take to build the pipe under the Spring Valley specifications, and it had to be fabricated according to the specifications of the Spring Valley. I did not have the Spring Valley specifications when I made this out, but when the pipe was made, it was made to comply with the Spring Valley specifications, and I took my data largely from notes I made at the time the Spring Valley pipe was built. That is the only thing I did use, the data cost as to the Spring Valley pipe.

Questioned by Mr. Greene.

We were not making other pipes when we were making the Spring Valley pipes. During the period that I was with the Risdon Iron Works we made lots of other pipe, but these figures here are what
4897 it cost to make the Spring Valley pipe, and they are the shop costs.

Questioned by Master.

This is taken from actual work; we found from weeks and weeks of experience that we could punch so many sheets per day, that we could fabricate so much pipe per day, and we had so many men employed, and therefore, that was the cost of the pipe. What they had in the books would be something I could not tell, and is a matter of indifference to me in making up this estimate.

Questioned by Mr. Searls.

The overhead percentage of 50% was what we used to make the 4898
costs. Most all of the work was done on a 50% basis. I do not know what became of the books of the company.

SIXTY-NINTH HEARING. NOVEMBER 30, 1915.

Witnesses: DANIEL DORWARD for Defendants.
F. W. G. MOEBUS for Defendants.
GEO. L. DILLMAN for Defendants.
ALLEN HAZEN for Plaintiff.
F. C. HERRMANN for Plaintiff.

DIRECT EXAMINATION BY MR. SEARLS. 4901

My costs show the true cost of the work, but whether the books of the Risdon Iron Works show the true cost of the work or not, I am unable to say. There is an addition of 50% to the figures contained in my table. I took the actual wages paid at that time, and added 50% to the wages only, and not to the material. We usually used to add to the material we bought 10% for handling and odds and ends, but the labor was taken at the payroll rate, plus 50%. In this case the material was furnished by the Spring Valley, so that 10% would not be applicable.

Questioned by Mr. McCutchen.

That is to say, that we bought the material, and fabricated it. 4902
We charged 10% on the cost of the material, but if we did not buy it, we added nothing to it. If we bought the material, we added 10% and called that cost; the payroll labor with the 50% added was the labor cost; to the sum of those two was added a certain percentage for profit.

Questioned by Master.

This 50% does not include the shop's profit, but was to cover what is called overhead. The transporting was done by the Spring Valley Water Co., and I do not know what the actual cost was, except from my experience; I know that the railroads charged 5 cents per 100 pounds, and then there was handling and teaming besides, so that is an estimate based on my experience. The Risdon Iron Works

laid all this pipe that is referred to in these tables, and I was in charge
4903 of that laying. We had time-keepers or cost boys noting the work done.

Questioned by Mr. McCutchen.

When we purchased the material, the usual practice was to add 10% to it, and call that cost. We figured it required 10% to pay for the cost of handling the material by the men in the yard gang, the storekeeper, and so on. The Spring Valley plates on the 54 inch pipe came in by rail right to our manufacturing department, and were hoisted off of the cars there without extra expense. Such expense as there was for handling was included in the making of pipe.

Questioned by Master.

The Risdon Iron Works did not pay any material bills for the Spring Valley pipes, except some small lots, and the 10% was not
4904 included, because that material was brought into the works by rail, and the shop work was so arranged that the material was handled at a very small cost, which cost was included in the making of the pipe.

Questioned by Mr. McCutchen.

If we had bought the plates, and had them transported here for fabrication, we usually would have added 10% of that cost. In other words, we would have taken the aggregate of the cost of the plates in Pittsburg, if we had bought them there, plus freight from Pittsburg to San Francisco, and to that aggregate we would have added 10%. The cars on which these plates were loaded would have been switched right into our yard, just as the Spring Valley cars were, at $2.50 per car switching charge, which amount we considered as cost, and to that we would have added 10%. The case of the delivery of the Spring Valley plates was not identical with deliveries of plates purchased by the Risdon Iron Works, because the Spring Valley delivered the plates to us. The Spring Valley had a car switched into our yard, on which the plates were loaded, only in case of the 54 inch pipe; the other pipe was built in the old establishment down on Beale and Howard Sts., and came in by team, because we had no spur
4905 at that time.

Questioned by Mr. Searls.

The 10% is just overhead—cost.

Questioned by Master.

If the Risdon had bought the pipe, the cost of the teaming would be added to the cost of the material, and to that we would add 10%, which covered general overhead, but no profit.

DIRECT EXAMINATION BY MR. SEARLS.

The reason the 10% was added in the case of the other pipe, and not in the case of the Spring Valley pipe, was because the Spring Valley delivered the plates to us right in our factory, and in the case of the Risdon supplying the material, they would have to bear

the cost of delivering it into the factory. We would include in the 10% whatever the cost of delivery was; for instance, if the team charged $10, there was 10% added on that.

Questioned by Mr. McCutchen.

If the teamster charged $10 for hauling that plate, that $10 represented part of the costs, and to that $10 we added 10%, or $1, to cover overhead. 4906

Questioned by Mr. Searls.

In the case of the Spring Valley pipes, where they brought them in themselves, we did not have to stand that charge.

Questioned by Mr. McCutchen.

This estimate that I have before me was made up last week. At that time I had some loose sheets, and I am positive a portion of them were destroyed, because after I had the estimates made up, I had no further use for them. I had kept them all these years because I had no occasion to make up an estimate from them, but I destroyed quite a number of them after I made this up.

Questioned by Mr. Searls.

They did not contain any matter pertinent to this case which is not shown on this estimate.

Questioned by Mr. McCutchen.

The figures which I have in this exhibit are not the identical figures which were on my memoranda that were destroyed. This is a collection of the figures that made up the cost of the pipe; when we 4907
bring pipe into the shop it has to go through certain methods. The first was shearing the plates to a given size. Then there was a punching method which cost so much. Then from the punching there was scarfing, the edges and corners thinned down. Then they were rolled and bolted together, and reamed or pinned out to get the rivet holes fair, and then it went to the riveting machine, and the up and down seams were riveted. Then they were put into a pressing machine and pressed together, after which the roundabout seams were riveted, and after that was done, they were shifted over to the calking department, where the joints were calked; from that they were delivered to the Spring Valley to be dipped. The first line, which reads: "making only, per pound equal $.0103 per foot equals $9.70", is made up of the different methods the pipe has to go through. I have not the cost incurred in going through each one of these operations, but I could make that up. A good part of that detail information was on the notes which were destroyed. It would not be necessary for me to have those destroyed notes in order to make this up, as I could make it up from my head, and from data that I have in book form. 4908

Referring to the item "pipe not coated, average equals 94 pounds per foot. Coated equals 100 pounds". I got the weights as follows: After the pipe was finished, it was weighed, but there were two lots

of pipe. The first lot of 4,500 feet was made weight per square foot, and that means when you take the plate per square foot the theoretical weight is so many pounds, but if you take a plate according to what they call gage—that is where the thickness must be maintained at the edge of the sheet, it is swelled in the middle and runs higher—there were 2200 feet of this pipe that averaged somewhere about 99 pounds per foot, or 98 against this 91, so the average weight of the
4909 30 inch by ¼ is 94. That weight was taken after we were through calking and ready to deliver it to the Spring Valley Company. The weight of the pipe coated we got by weighing, but we did not do the coating. We weighed most of them, and kept a record of their weights.

Questioned by Mr. Searls.

The kettles are the kettles in which the dipping fluid was made up. The pipes, before they can be laid in the ditch, have to have the asphaltum cleaned off each end, and there were two men doing that all the time. This estimate does not include coating, trench work, backfilling, or the material in the fittings. The cost of attaching the fittings was included in the laying of the pipe. The kettles were our own, and we supplied them, but there was a question about that—
4910 there were three or four items there in the cost of which, the kettles were not mentioned. In the 54 inch pipe it was distinctly stated that the rental for the kettles was to be so much. There was no agreed price in the others.

Questioned by Master.

In the case of the last pipe, which was built over at the Potrero, in the new works, we had to build the works and put up the kettles, and as we did not have any profits from the coating, we agreed on a rental for the kettles of 12½ cents per lineal foot.

Questioned by Mr. McCutchen.

The supervision and direction of the laying of the pipe came under the machine department, which was my department, but of course, I had charge a great part of the time of the construction work in different departments. At the time this pipe was laid, the ma-
4911 chine department was in charge of the work of laying, and a Mr. Moore was the general superintendent of the work. He and I spent considerable time supervising the work. On the first of the work Mr. Moore was in charge of the 44 inch pipe—the San Andres—and I was his assistant then, and had considerable to say about the handling of it. The costs of laying did not go directly to the office. We had time-keepers on the work who reported to the office, and generally gave me a copy of the work done. I was in the shop generally, but spent a portion of the time in the field, and the time-
4912 keeper delivered his time sheets to the office, and the office usually made entries directly from his time sheets. It was the duty of the
4913 time-keeper to report to the office, and not to me. My visits were frequent to the work, and both the time-keeper and the foreman told

me how many men they were employing, and that gang did not vary; I found on the average the number of feet of pipe they were laying per day with so many men, and I knew the wages that were being paid, therefore we came pretty close to the cost of the work.

I know that we were continually estimating on work, and it was our instructions to find the cost; for instance, the boiler maker, and the handy men, and the helpers, and we had to estimate a rate for them; the boiler maker would be about $3.50 per day, and the helpers and handy men the same; we had that established rate, 4914
to which we added 50%. The same thing occurred in the field. Most of the skilled men were sent from the works, while the ordinary rough and tumble help were picked up in the country.

The time-keeper's reports were made to the office from time to time, of the shop labor expenses. That went directly from the shop to the office, and when the work was done on the outside, the time-keeper reported that directly to the office without going through the machine shop. It was also generally reported to me, but I do not say that every item of it was so reported. Whenever I wanted that information I got it, but the foreman in the field had no connection with the office whatever. His connection was with the different departments of the works. When a piece of work of that nature came into the Risdon Iron Works, Mr. Joseph Moore, who was alive then, made most of the figures for the purpose of determining the bid. When he retired, his son Robert, who succeeded him made a great many 4915
of them, and I made a great many of them. I have made a great many estimates. The outside work on the Spring Valley job was not in my department; on the 54 inch it was in my department.

The man in the field was mostly responsible to me, and sometimes to Mr. Moore. I appointed a great many of those foremen who had charge of the work. Therefore, I was considered responsible for them carrying the work through efficiently.

DIRECT EXAMINATION BY MR. SEARLS. 4916

The figures shown on these tables are correct to the best of my knowledge and belief, and they are an estimate of the cost of fabricating and laying the Spring Valley pipes, by the Risdon Iron Works.

Introduced and received as "Defendants' Exhibit 103".

I have made an honest estimate of the cost, to the best of my 4917
ability, but there are odds and ends that creep into all big establishments, especially on large jobs, and the 50% covers these items, which are a very small portion usually of the 50%.

In addition to making these estimates of cost, I made a table which purports to show my estimate of cost of reproducing such of the Spring Valley pipe lines as were originally built by the Risdon Iron Works as of December 31, 1913, and these figures are correct to

the best of my information and belief. To explain how I made these reproduction figures: The wages increased from 1884 to 1913 12% for men making this class of work. We reduced the hours of work in the factory 20%, so that made an increase of 32% in the cost to reproduce it in 1913. In the field we increased our wages 12%, and reduced the hours of labor 10%. Labor has not increased in efficiency in
4918 that period of time.

Questioned by Mr. McCutchen.

Labor has the brains today that they had in the old days, if they use them, but it is a fact they do not use them in the interests of the employer.

DIRECT EXAMINATION BY MR. SEARLS.

That will give you the additional cost; against that we know that we could not get the same profit in 1913 as we would have gotten ten or fifteen years ago. Therefore, that reduces the apparent increase of
4919 cost. You take the actual cost and add 30% or 35% at the outside, and it would be all you would expect to get. In those days 50 to 60 percent was the profit, but in 1913 to 1915 you cannot get any such profit, on account of competition.

Questioned by Master.

I do not refer to the 50% overhead when I say profit. I refer to the amount that is added to the payroll cost, plus the 50%; the amount that is added to that would be the profit, and that is something that I have not attempted in these tables. My first page of the latest sheet, 1913, shows a reproduction of the 30 inch by ¼ with my final figure of making, laying, and transporting, as 2.61 cents, as against 2.24 cents at the time of making. My estimate of shop costs is the same as it was before, and I have obtained that by applying these percentages to my former figures, and that includes
4920 the 50%. There is no profit included in either case. The tables that were made up and revised last night vary a little bit in the cost of reproducing, as I eliminated the cost of attaching the extra fittings.

Mr. Searls: The following are the totals for the remaining sheets; 44 inch No. 6 $.01971. 44 inch ¼ $.01735. 54 inch, 9-32, $.02098. These figures are all somewhat higher than Mr. Dockweiler's corresponding figure, but I think somewhat lower than Mr. Hazen's.

Mr. Hazen: I think Mr. Dorward's is just the same, practically speaking, as mine.

Mr. Dorward: The profit is not included in these figures that I
4921 have given here, and the percentage of profit that I would add under the conditions in 1913 on a job like this, would be 30 to 35 percent.

Questioned by Mr. McCutchen.

In the period 1907 to 1909 competition was nothing like as fierce as it was in 1913. There was a living profit in the business then. The

condition that prevailed in 1913 began, I should say, in about 1910.

Six sheets introduced and received, and marked "Defendants' Exhibit 104".

DIRECT EXAMINATION BY MR. SEARLS. 4922

I do not think it would cost as much as 20% additional to do work on this coast as it would in the East, speaking of labor costs, and not considering the freight. The wages in the East are considerably less, and the hours of labor are longer, but men here will do more work per day than they will in the East, due to climatic conditions principally; in winter time they are freezing, and in summer time roasting, but here the men work in shirt sleeves the year round, and consequently they do more work.

Questioned by Mr. Hazen.

The cost is greater here than it is in the East. We are probably paying about 10% more wages here, and working 10% shorter hours than they are in the East, but deducting from that the extra amount of work that men can do here, amounting to about 10%, would make the eastern pipe from 10 to 12 percent cheaper than it could be manufactured here; but against that we should consider the cost of transporting the finished pipe to the Coast, against transporting the raw material. For instance, on a car there are certain sized pipe you would get half a carload of, and you would have to pay more than the carload rate, or else you would have to pay for the full car, but altogether without the figures I should say that the eastern pipe would be 10% to 12% cheaper than the pipe made in California. 4923

CROSS EXAMINATION BY MR. MCCUTCHEN.

Taking all the elements into consideration, that figure is correct. I was with the Risdon a great many years, and with the exception of some small lots, I was with that company during all the time that it was engaged in manufacturing or fabricating pipe for the Spring Valley Company. The three lines that I have spoken of were all made during the time that I was in charge of the machine shop at the Risdon, the 44 inch being the first. The pipe was well made, and it could not have been better made. The work was all done by special machinery. First, when the sheets came into the shop they were put on a frame and put under rotary shears, and the edges beveled, and then from there they went to the punching machine; after punching they went to the scarfing block; alongside the scarfing block are rollers for rolling the courses; after that the men called the pinners take hold of them, and go up the courses, and drive a rivet in the holes before it goes to the riveting machine; from there 4924
it goes to the riveting machine, which was all operated by hydraulic hoists overhead, and hydraulic riveting machine. That first operation of riveting was up and down the straight longitudinal seams;

after that we pressed three courses together, and then we bolted them, and took them to the roundabout riveting machine, where the roundabout riveting was done; then there were two more courses put on, and we kept extending the pipes that way. We put them together by two, one on each end. When that riveting was done, and it was inspected by Mr. Schussler's own inspectors, who were on the job all the time, it went to the calking department, and after they were thoroughly calked, inspected and passed, they were sent over to the dipping kettles in charge of the Spring Valley. Then they passed beyond our control until we got them at the edge of the ditch or trench.

Questioned by Master.

We used a pneumatic tool on the 36 inch, some of the 30, and 54 inch; when we made the 44 inch we did not have pneumatic tools, but used hydraulic riveting machines. There was pneumatic calking and hydraulic riveting. The pipes were made in the boiler shop, and
4925 adjuncts at the pipe shop, and the foreman boiler maker was under me. When I was general foreman, I had general charge of that—while the immediate construction was under these men, the general supervision was under me, so in a general way this was my work. I was not so fully in charge of the 44 inch as I was in the latter line, but still I had charge, as I had to see that everything was in working condition, and the job was a first-class job. There is no question but that when each of these lines were finished it was an extraordinarily good line of pipe. The Spring Valley was getting first-class work for a good price. It might have saved a little something on the methods employed, such as the inspection and care that was taken, and I do not think that it would have been detrimental, but altogether they
4926 got a good job of work.

The last big pipe that we laid was in 1910, for the Union Construction Co., up on the Stanislaus, above Murphy's. When you speak of the pipe made nowadays, you have got to consider where it was made, because if you pay a cheap price for it, you will get poor work. You can find pipe at various prices in the market. When you get it at low prices, you will get the cheapest kind of steel, full of sulphur, that won't last as long; the workmanship will be slighted wherever it can be, if the establishment making it is not responsible. Unless we can get a good price for doing first-class work, we do not want it, but there are concerns that are willing to take it at below first-class prices. The fact that you got a list price, or a
4927 quotation on pipe of certain dimensions, without specifying just how it was to be made, would not be very enlightening in determining the value of that pipe. You can get various quotations on pipe. You can get quotations of the very highest class of work, and quotations for reasonably good work, which would be somewhat less. There would be quite a variation between the prices of excellent work, and

of indifferent work. 15% might be close to that variation between the good product and the indifferent product. You might get one bid for poor work that would be 15% below good honest work. If you put high-class iron against poor steel, there is much more variation. There might be a variation in that case of 25 to 50 percent. It would not go beyond that. 4928

Questioned by Mr. Hazen.

My figures do not include the bends. The bends usually are considered a part of the pipe, but in certain cases where the pipe was somewhat crooked, the bends were allowed for extra. My estimate is for straight pipe. My estimates do not include dipping.

Mr. Metcalf: Adding 35% profit to his figures, as he states, and making an allowance of seven-tenths of a cent a pound for the dipping, and it will probably exceed that, on Mr. Hazen's figures it did 4929
exceed that, the 30 by ¼ pipe, 36 inch No. 7, and the 36 inch No. 9, are all slightly higher than Mr. Hazen's figure, but are almost exactly his figures; the 54, nine-thirty seconds of an inch thickness is almost the same, slightly lower; the 44 inch No. 6 ¼, are slightly lower than Mr. Hazen's. I do not know what the average is, but they are very close.

Questioned by Mr. McCutchen.

We do not consider we can get as much work out of a man today as we did 10 years ago. We can get probably 75% of the work hour for hour today that we could 10 years ago.

Witness: F. W. G. Moebus for Defendants. Moebus

DIRECT EXAMINATION BY MR. SEARLS.

I reside in Alameda, and am 67 years of age. At this time I do very little, but during the years 1911 and 1912, and prior to that, 4930
I was with Francis Smith & Co., who were engaged in the sheet-iron and pipe manufacture, as general manager. At one time they did all that class of business that was done in the state; in later years it was not so much. They built large quantities of riveted pipe, both steel and wrought iron. I was general manager of the company about 25 years, and during that time they had occasion to build pipe for the Spring Valley Water Co. The principal line that we built was the main supply line on Howard Street, in San Francisco. I made the shop costs of the company myself, and finally, after Mr. Smith gave it up, I made the estimates for the company in all their work. I received the reports of the shop foremen, time-keepers, and so on, every day. I have not preserved any data as to what those costs 4931
were, but I remember very clearly what they were on that particular job.

Questioned by Mr. McCutchen.

4932 I do not remember the length of that line, but it was laid some years ago, and was quite a long line.

Questioned by Master.

The size of the pipe was somewhere along 36 inches.

Questioned by Mr. McCutchen.

The shop costs were reported to me by men actually on the job. Each man made his reports to the foreman every day, and each individual report was sent to me.

4933 DIRECT EXAMINATION BY MR. SEARLS.

Mr. Smith was in very close touch with his business himself, but in later years I did all the figuring on all large pieces of work that came to the shop. Mr. Smith was very active during his connection with the house, and was in close touch with all the business that went on. He went out in the field, and gave the laying of pipe his personal supervision. There were several cases that he did not see at all

4934 where I had charge of it. We had a regular shop cost that we used in figuring Spring Valley work, and for the making of it, which was 1 cent per pound on the 36 inch 1/4 and 3/16. The 1 cent per pound included everything in turning the pipe out ready to be coated, but did not include the shop overhead. For that we added about 10%. The contract prices will speak for themselves as to the profit we made on those jobs. From 1907 up to the first of the year 1912, the increase in our shop costs, from the figure that I have just given, would not have been very material, for this reason, that our appliances for manufacturing pipe were better in the later years than before. We could, in a measure, overcome anything that might have been in the way of the labor. The profit that a pipe manufacturer bidding for work between 1907 and 1912, would expect, was very variable; it would run all the way from 15 to 25 percent, but would very seldom

4935 exceed 25 percent. If I were to take my 1 cent a pound and add 10% for overhead, and then a maximum of 20 or 25 percent for profit, so far as the shop costs of the pipe were concerned, my fabrication costs would be about 1.30 cents.

CROSS EXAMINATION BY MR. MCCUTCHEN.

The increase from 1900 to 1912 for labor cost was not very great as to the actual amounts paid per hour in money, although there was an increase of about 25 cents a day on some of the men. We

4936 ran a non-union shop, and did not work on union hours. We insisted on running an open shop, as we thought it was the right principle. It might have hampered us if we had been compelled to work on closed shop principles, and it might not. We worked on the open shop principle because Mr. Smith always contended that he did not believe any man should interfere with him in the running of his business. Our shop costs were about the same in 1900 as 1912, and

I think we worked our men the same hours in 1912 as we did in 1900. We first started with 10 hours, and then we reduced to 9. The 10% overhead I figured was the expense which it took to run the shop, and it was just the same when we bought the plates and fabricated them as when the plates were supplied to us by others to be fabricated. 4937
If we bought the plates and fabricated them, our overhead was charged on the cost of the plates, and that 10% was all of the overhead, and included the office overhead as well. We did not actually make an entry in our books of the overhead, we added it to the profit; when the estimate was made of the costs, then it was added. I added it to the profit and made one matter of it. It was based on the actual expense of running the business, taking it for a year. If work came in to us, and I wanted to determine what the cost of it was going to be, I would add the 10% after making my estimates of the cost of material and labor, and I would add a profit in addition to that. When a job was to be estimated, I took the costs of material, estimated the weight of the material, estimated fabrication on that weight of 1%, added those two together, then added 10% to that, and then added a profit, and that was my bid. I do not recall whether Francis Smith 4938
& Co. laid what is known as the Pleasanton line. We laid a pipe for the Contra Costa Water Co. over there in the 90's, but I do not remember having laid a pipe for the Spring Valley Co. there in 1909. I was East for about 3 or 4 months, and it may be that that job was 4939
done at that time, and that is why it is not impressed on my mind.

Mr. Hazen: $100,000 was the whole cost on that, including the laying. It was about $40,000 or $50,000 for the pipe.

Mr. Moebus: I think we did make a lot of pipe for the Spring Valley in the shop, but we did not do the laying at Pleasanton. The cost of 1 cent a pound was on well-made pipe, as we never made anything but well-made, so that if we made this Pleasanton line, it may be 4940
taken as a fair sample of the work that we did in making other pipe. In making this Pleasanton line, or in making all the pipe for the Spring Valley, we made it according to specifications.

Mr. McCutchen: Mr. Smith undertook to make that pipe, and Mr. Bourn told him to go ahead and make it, and there were no specifications for that.

Questioned by Mr. Searls.

I once had a comment from Mr. Schussler on the quality of work turned out by our company. When we were making this line, Mr. Schussler used to come down to the work and look at it, and after it 4941
was finished, I asked him how he liked it, and he said "Mr. Moebus, I didn't know that you folks could turn out such good work; I will see to it that you get a lot of our work hereafter." I have a distinct recollection of the shop costs of the Howard Street job, and I figured that at 1 cent per pound, because I was very proud to get that order from Mr. Schussler.

Dillman

Witness: GEO. L. DILLMAN for Defendants.

4942 CROSS EXAMINATION BY MR. GREENE.

I am a member of the American Society of Civil Engineers, and am in receipt of Monthly Transactions.

(Counsel for Plaintiff handed the witness a report, Volume 40,
4943 No. 9, November 1914, which contains the report of Mr. Clark on the 24 inch line of the second Bull Run submerged pipe, and asked witness to state what the cost per foot of that pipe was on those figures. It was decided to allow the witness an opportunity to read the report before making reply.)

4944 Mr. Metcalf: We have prepared here a statement which is a comparison of reproduction costs estimates with those of Allen Hazen upon earth dams and flumes. The main figures have been taken from Mr. Hazen's detailed estimate, and in parallel columns—column 23, 24 and 25 on Page 1—are shown the corresponding figures of Mr. Hermann, Mr. Dockweiler, and Mr. Dillman. We have entered in this comparison merely the footings of the various items, and in the case of the most important items, aggregating large sums of money, such as the Pilarcitos Dam, item 1, we have also shown in parallel columns unit costs; as to other items involving small reproduction costs, we have not shown the unit costs.

Hazen

Witness: ALLEN HAZEN recalled for Plaintiff.

Mr. Hazen: I will take up the discussion of Pilarcitos Dam, Page 1, and the San Andres Dam, Page 14. The figures which are entered in this schedule represent in my judgment the fair estimated cost of reproducing the work at the present time, and by the present time I mean from 1907 to 1914. In all my appraisals my figure is generally intended to be a composite of those 8 years. I would make
4945 my adjustment between different years by subtracting the cost of new structures coming in.

Mr. Dillman: It was the intention that my appraisal would cover the entire period as Mr. Hazen has it.

Mr. Hazen: These dams were made by gathering up earth and clay, and suitable materials from the neighborhood, and depositing them in an earthen dam with a clay wall, in such a way as to make a water tight structure. Preliminary to construction it is necessary to take off all the soil and other loose material on the surface of the ground over the whole area to be covered, and to dig a trench down to hard impervious material along the center line of the dam, and refill that with impervious material. An estimate also covers the spillway, the outlet works, and other appurtenances. In making the estimates for these two dams, I was guided particularly by my own

experience in dam building, and by observation. I designed, a few years ago, a dam of about the same height as these dams, but not quite as long as either of them, so that the yardage was somewhat less; that was built under my oversight. Also another dam, not quite as high, and besides that, I have made designs for a good many dams, some of which have been built, but I have been familiar with what has been done in dam construction. 4946

The first one is the Borden Brook Dam of the Springfield Waterworks. The physical conditions were in many respects quite comparable to those at Pilarcitos. The dam was rather remote from the base of supplies, back among high hills. Of course California is not New England, and there are differences that are understood growing out of that. Passing that, I think it was about as comparable a case as could well be found. That work was done by contract—by a very energetic enterprising contractor, who had a great deal of skill in construction—from our plans. The contract price for the embankment was 69 cents a cubic yard. It is my impression that the work was done at a small profit to the contractor; it was done promptly and well. The whole cost of the dam when it was finished, including all these extra things that are listed in this schedule, and that form part of the dam, which I think of in estimates ordinarily as part of the dam, the whole cost of the Borden Brook Dam came to 94 cents a cubic yard, including those items. 96

The other dam was also built for the Springfield Waterworks, and I think was about 40 to 50 feet high. It was built in large part with surplus material from other work that was being done in this neighborhood, so that it was difficult to separate the cost of that and figure it as an independent structure. We paid 16 cents a cubic yard, under a contract, additional for material deposited in this dam, which otherwise would have been deposited in the spoils bank. That material 4947 made up quite a part of the dam; for the rest, material was got particularly from a neighboring borrow pit, and cost 86 cents per cubic yard.

Questioned by Master.

The Borden Brook Dam was built as follows: The material was sometimes loosened by blasting; it was not rock, but was very firm material; most of it was not necessary to blast, but sometimes it was loosened in that way. It was then taken up by a steam shovel and loaded ordinarily on to carts, and drawn a short distance, usually a down hill haul, to the dam. It was taken on to the dam, and the material was classified according to its character, the clay material going in the center being most impervious, and the less impervious material going on the sides of the dam. The material was broken and spread by men with tools after being dumped, and then was rolled in about 6 inch layers with a 10-ton grooved roller, which takes the place of the lighter horse drawn rollers that used to be used; it is as

efficient, and more economical, because one trip with a heavy roller takes the place of quite a number of trips of the lighter horse drawn rollers. The outside of the dam was protected by stone rip-rap, the stone being obtained from the material obtained in excavation. The dam was provided with the cutoff and outlet works that are customary, and that correspond to the works for these dams. The care of water during construction is always something of an element in the construction of a dam of this kind. When the dam is started, and gets up to a certain height, there is danger that a cloud-burst
4948 or sudden rain will wash out the work. That has happened, and is one of the hazards. Ordinarily some chances are taken; that is, less than provisions for the largest cloud-bursts are made, but considerable provision always has to be made for the care of that water during construction, and that is ordinarily done by works somewhat temporary in their nature, and which disappear when the work is completed.

In considering the application of this eastern experience to California conditions, I took into account that labor costs more here. On the other hand, the climate is more favorable to construction in California. The thing in New England that interferes more than almost anything else is the heavy rains that sometimes come in the summer; those rains are quite demoralizing to a job of this kind where the material is clay. In California there is a long season where that is not a contingency, where the work can go forward without that interruption and delay. It seemed to me that the advantage from the standpoint of climate in that respect practically offsets the increased cost of labor. As nearly as I could get at it, it would cost just about the same to build the Pilarcitos Dam as it cost to build the Borden Brook Dam. I do not mean that as relating to every item of construction, but I mean looking at it broadly, and that is practically the way that I made up these estimates. I have estimated the embankment at 65 cents per cubic yard. Bear in mind, the cost of the dam as a whole, and the gross yardage, which to my mind is a more
4949 satisfying basis than comparing simply the unit prices. I find the Pilarcitos Dam containing 371,502 cubic yards—that includes the main item of embankment, and also the puddle, and also 300 cubic yards for concrete in puddle trench. I take those three items substantially as making up the yardage of the dam, and the cost of the complete dam, including structures 1 to 7 inclusive, and then 14 and 15 which are separated in position, and adding those up from the schedule, I find that the whole cost of what I should call the Pilarcitos Dam is $350,461, which is equal to 94 cents a cubic yard, or exactly the record cost of the Borden Brook Dam.

For clearing the reservoir site I have $60 per acre. I took that out, and when I made this calculation I took out that stripping from Structure No. 1, and the amount that I carried was the total less that

item, because that is not part of the dam construction that I ordinarily estimated separately.

Questioned by Master.

I assumed the reproduction of this embankment by steam shovel as far as it could be used. In order to get the material for the Pilarcitos Dam, it is apparently necessary to open a good many small pits, no one of which is big enough to give a real satisfactory face for steam shovel work, but I assumed that the steam shovel would be used just as far as a suitable face could be obtained. It is also my judgment at the present time that a good deal of the softer rock could 4950
probably be worked into the embankments by blasting it, and handling it with a steam shovel, and by doing it in that way, at perhaps much less cost than going to so many small borrow pits for earth. I do not know certainly that it could be done that way, but it occurs to me that possibly it could be, and what I have seen done at Calaveras recently rather supports that idea. Possibly a little saving in cost would be made that way, though I do not think very much, because the cost of handling the rock would be pretty nearly the same as doing it the other way. It would not make a dam that would be identical with it, but so far as I considered that, I consider it would be equivalent from a standpoint of work and service. This is a dam of selected material, fine rock, and my dam would have a good deal of course rock on the slopes. I did not base the estimates on that, but I thought of it as one of the possibilities. It is my thought in regard to this that all the estimates have every method that is in current use within this period that we are talking about, and if advantageous would be used if it showed to the advantage of that particular work.

For the San Andres Dam, using for the most part the same unit prices, but with a little different arrangement of the relative quantities, I have a total volume of 517,572 cubic yards, and for structures 1 to 9, $521,439. The estimate amounts to $1.01 per cubic yard. The auxiliaries raised the base cost on the San Andres Dam a little 4951
more than they do on the Pilarcitos. In making preliminary estimates for dams in New England for some years, as a result of various experiences, I have commonly used for a preliminary figure $1 per cubic yard on the gross volume as a first approximate figure. It has worked out pretty well. If the material is clay, it will ordinarily cost something like 70 cents or so per cubic yard for the main work of the dam. The other structures will bring up the total to about $1 per cubic yard. If the material is a sandy material, the cost per cubic yard of handling will be considerably reduced, and the base cost will drop from 70 to perhaps somewhere between 50 and 60 cents per cubic yard; on the other hand, the core wall work is also much more expensive where the sandy material is the base of the dam, than where clay material is the base of the dam, and so the increase in the cost of the core wall nearly offsets the saving in

cost per cubic yard on the main part of the work. The cost of the dam is not very much affected within certain limits by that change in material.

The amounts allowed for the concrete in these dams I can discuss better in connection with the concrete schedule.

The trench work is something of an item. On the Pilarcitos we have 6400 cubic yards, at $2.50 a yard. That is very expensive work, because it is done at a low level; there is apt to be water that has to be kept out by pumping. The trench is relatively narrow, and
4952 particularly when you are getting to the bottom the excavation has to be done with a good deal of care. It differs in that respect from an excavation that goes to an arbitrary pre-determined line. The way this is prosecuted is that the material is taken out a little at a time, looking always for a satisfactory, sound bottom, and it adds quite a good deal to the expense doing it in that way. The benching of the old dam for an addition represents an added expense in this case, because the dam was built to a lower height and raised, but I made no addition for that; I figured on reproducing the finished structure, without any addition for the peculiar way this was actually made. I made some investigations about the rip-rap. I got Mr. Lawrence to dig holes for me at representative places so that I could see how much of it there was, and what kind of material it was, and the figure I reached was reached after that inspection.

Questioned by Master.

This rip-rap was stuck in the face with the point of the rock out. The rip-rap that is laid like masonry we call paving, and it
4953 costs a great deal more. There is some rip-rap on one side of the Crystal Springs Dam, which, I think, is paving. It is in front of the Howard Cut.

Puddling is, unfortunately, getting to be a lost art. The engineers of the former generation attach a great deal of importance to puddling, and, fortunately, I had experience when I was a beginner with a man who thoroughly understood puddling. I have placed a great deal of puddles in my work. It has been displaced in recent years very largely by concrete in reinforced concrete structures which have been used in place of puddle. I think, generally speaking, it has been an unfortunate change; there have been a great many reservoirs that have been water proofed by concrete that leaked, and leaked so as to make them unsatisfactory; they might have been tight if puddle had been used. The cost of making puddle varies a great deal with the materials that are available and with the methods that are used. I have known puddle to be placed at a cost of $5 or $6 per cubic yard. In my own experience I think $1.50 has been about the representative normal figure, and that is what I used in this case. I recognize that there is some uncertainty as to just what was done in this case, and as to just what it would cost to re-

produce it. I think this figure is a fair estimate, based on such information as I could get. The dams, I think, are entirely tight, which has some bearing upon the efficiency of the methods that were used.

The clearing of the reservoir site in this case was put in at $60. I think in different parts of my schedule you will find a little variation in the estimates for clearing, depending somewhat upon the country and the growth. My judgment as to the growth was formed 4954
by the growth on the neighboring lands, which seems to give an indication of the probable growth on the submerged lands. That clearing in our Eastern experience has averaged a cost of about $50 per acre. I think that at Pilarcitos this work would cost a little more. There was no stripping done, and none estimated, except under the dam. There was no stripping of the reservoir site.

Questioned by Mr. Greene.

On the estimate for clearing, the variations in costs that I used were due to variation in the condition of the lands that were to be cleared. I find I have $60 for both of these reservoirs. The reason for the 60 cents per cubic yard for embankment at the Upper Crystal Springs as related to the Pilarcitos and San Andres at 65 cents, was due to the fact that there were better borrow pits at the upper Crystal Springs. I made an estimate for the Upper Crystal Springs Reservoir, but I was not speaking of that in regard to what I have said up to the present time. That was made though in the same way, and for the most part, of similar unit prices to those two, but I did not study that very hard, as I did not attach very much to it be- 4955
cause it practically has ceased to be used as a dam. It performs a very important function in carrying the road, and in keeping the water separate in the upper portions of the reservoir; that keeps muddy water back, and permits the delivery of water of better quality than would otherwise be possible, so I consider for this purpose that practically this dam would be represented by an embankment built like an ordinary road embankment, but provided with the sluices and appliances that are necessary to let the water go underneath. I filled out the items that are in the schedule with unit prices corresponding with the other dams, but without giving any very detailed study to them, and then depreciated the sum so found by an amount, which, in my judgment, reduced the total to what it would practically cost to build an ordinary earth embankment to carry the road, and to perform the functions that are served by the dam at the present time. Knowing I was going to do that, it did not seem to be necessary to take the time to study it very hard as a dam.

Questioned by Mr. Searls.

The units given on page 32 show no depreciation. I depreciate the Upper Crystal Springs Dam 60% upon the basis that I have just described, so that it stands in the schedule, including overhead, at

4956 $135,000, that was really based on an entirely independent estimate of what it was worth on the other basis.

Questioned by Mr. Greene.

These are the only important dams. There was an old Pilarcitos Dam that is not performing any service, and I did not estimate that. Then there is a small dam in San Mateo Creek, but it is a small matter. I estimated that at the same unit prices I was using otherwise. The two different Colma Dams are a part of the Merced drainage system. I had not thought of those as dams, though I guess they are called dams in the schedule. To all three of the larger dams I applied the same unit, $1.50 a cubic yard for puddle fill. I do not know of any condition that calls for a variation in that unit.

Referring to the figure of $2.50 for puddle trench for the Pilarcitos and San Andres, as relating to $2 for Upper Crystal Springs, I presume that the trench was not as deep or as difficult as the other. In the case of the Upper Crystal Springs Dam, as I said, I did not
4957 study that as hard as I did the other dams.

I am only familiar in a general way with the cost incurred in the construction of the Calaveras Dam, and with the methods employed there. I have seen several dams in the course of construction, and completed, at Los Angeles. Mr. Mulholland showed me those, and told me about them. I have seen the methods they are using in building them.

Questioned by Master.

I did not learn the costs in very definite shape. The two dams under construction at the present time were started as hydraulic fill dams. Very low costs were given out for the early part of the work, but as the work has progressed in both cases, the method of doing it has been changed, so that as it is being prosecuted at the present time, I see no reason for thinking that they are doing it
4958 any more cheaply than it would be done by the method I have in mind here. The possibility of building dams by the hydraulic fill methods depends upon the local conditions. Only some materials are capable of being handled in that way, and in my judgment there is not any deposit of material at either Pilarcitos or San Andres that could be advantageously used to build a hydraulic fill dam. I was very enthusiastic to build the Borden Brook Dam by the hydraulic method, but I gave it up very reluctantly because I could not get a deposit of material that I could count on using satisfactorily in that case. We built it by dry methods.

Questioned by Mr. Greene.

There is a large dam for power purposes, built by the hydraulic fill method, a little way from Vancouver, that I visited. I thought the conditions were so different that it would not throw much light on this.

Witness: F. C. HERRMANN for Plaintiff.

DIRECT EXAMINATION BY MR. GREENE.

I am 45 years of age, and graduated from the University of California in civil engineering in 1894. Then I was with Herrmann Brothers, at San Jose, from 1894 to 1897 on general surveying and engineering work. I designed a sewer system for the City of Grass 4959
Valley, and assisted in the construction of the work of the San Jose Water Co., particularly on the Williams Dam, a concrete dam about 85 feet deep in the Los Gatos Canyon, and in flumes, pipe work, and other work of that company. In 1897 I was the engineer for the Salinas Valley Irrigation Co., in charge of the location and construction of canals and flumes from the Salinas River, the San Lorenzo Creek, and the Arroyo Seca, with the intention of irrigating and colonizing lands between the City of Salinas and King City. In 1898 and 1899 I was engineer in charge of the Spreckels Sugar Co. on irrigation and drainage work on their various holdings at King City, Solidad, Spreckels, Chualar, and Gilroy, all in California. The work embraced field work, river control, leveling land, construction and operation of pumping plants, and the construction of a pipe line. In 1899 I was with the Fort Miller Power Co. I made the designs and estimates of a large power installation on the San Joaquin River, which was not built at that time; part of this scheme being the Big Creek Power Plant, which has just been completed under other ownership.

From 1900 to 1905 I was assistant engineer in the City Engineer's Office at San Francisco, under Mr. C. E. Grunsky, and for a short time under Mr. Thomas P. Woodward. My work there was that of preparing plans and specifications of different kinds for sewers and street work. I started the system of cost account that was first kept there. I also was given the solution of special problems, like re-grading and changing the alignment of 4960
streets in the hilly part of San Francisco. From 1905 to 1907 I was irrigation engineer under Dr. Elwood Mead, chief of the irrigation investigation, of the United States Department of Agriculture. I had charge of the investigation in the central part of the United States, inspecting the irrigation systems, and advising and assisting wherever I could in that connection on the various irrigation projects throughout Wyoming, Colorado, Texas, Idaho, some in Nebraska, and some in New Mexico. From 1907 to 1910 I was assistant chief engineer, and chief engineer of the California Development Co., and its Mexican subsidiary company in the Imperial Valley, on the Colorado River. I had charge of the construction of a large part of the river levees. I was on the second closing of the Colorado River. I had charge of reconstruction, maintenance and operation of the system in Imperial Valley after the river was closed. I built

about 200 miles of canal from 10 to 70 feet wide in the bottom; a large flume over New River of a capacity of 800 second feet, and a number of wooden and concrete structures throughout the district, and some earthen dams, one across New River, another across the Alamo River, and another at Alamo Mocho.

From 1910 to 1914 I was with the Spring Valley Water Co. as construction engineer and chief engineer. With Mr. Mulholland I designed the Calaveras Dam, and had charge of its construction during that period. From 1914 to date I have been in private practice, acting as consulting engineer for the Spring Valley Water Co.

4961 I have participated in the valuation of the Peoples Water Co. in its case before the Railroad Commission on re-organization; and with Mr. Elliott, now the engineer of the Spring Valley Water Co., I prepared a valuation of the San Jose Water Co. for its case before the Railroad Commission. I am in charge of the work of the Modesto Irrigation District, and the reconstruction of its main canals and structures, in which they are spending over half a million dollars, replacing temporary structures with permanent structures, including four or five large fills, put in by the hydraulic method, and reinforced concrete drops and checks, and a reinforced concrete flume of a capacity of about 1200 second feet, and about 600 or 700 feet long over Dry Creek.

I am a member of the American Society of Civil Engineers. I am familiar with the properties of the Spring Valley Water Co., particularly with its dams. I have prepared an estimate of the cost of reproducing new, the San Andres and Pilarcitos Dams, and the small clay dam in the San Mateo Creek. In this estimate I have borne in mind the methods that were used, and the character of the work in these earthen dams. I have borne in mind the use of modern ma-

4962 chinery, and have utilized my knowledge of the cost of work at about 1913. This appraisal is made as of December, 1913. It was prepared by me.

The appraisal was offered and received in evidence as "Plaintiff's Exhibit 105".

4963 I figured that the unit cost on the Pilarcitos and San Andres Dams would be about the same; I used the same unit prices, feeling that one was perhaps a little farther away, but with this character of work, that made little difference, and that the conditions of the two were such that the unit prices would apply equally to both. I took up each item in the schedule using the quantities there without checking myself, and accepting them as they were. I used the figure $67.50 per acre for clearing off reservoir sites, which I obtained as an average between the clearing on the hillside and in the bottom. The clearing on the hillside I estimated as $75 an acre, and in the bottom as $60 an acre. To arrive at this figure, I bore in mind several things, among which was the clearing off of the base of the levees for about

20 miles along the Colorado River, where the cost was about $65 an acre, including the grubbing of the mesquite and willow trees. The labor cost on that work—we used Mexicans and Indians largely —was $1.60 a day for a 10 hour day. If that is reduced to an 8 hour day at $2.50, it would make $128 per acre, including the grubbing. I am comparing white labor and Mexican labor for that class of work, because I believe they are just as good, and I figure that without the grubbing the cost would be about half of that, or about $60 to $65 an acre.

Questioned by Master.

By clearing I mean cutting off the tops say 12 to 18 inches above the ground surface. I have assumed that in the reservoir surface it was not grubbed, and the figures I have here are for clearing 4964
without grubbing. The clearing of the Calaveras-Sunol road cost about $53 per acre. That was done under my direction in 1912 and 1913, on the basis of a 10 hour day, at $2.50 a day for labor. Adjusting this to an 8 hour day, it would be equivalent to $66 an acre.

Questioned by Mr. Searls.

I adjust this to an 8 hour day here, because on the peninsula the time which the company works is 8 hours. At Calaveras they always have worked 10 hours.

DIRECT EXAMINATION BY MR. GREENE. 4965

The present clearing of the Calaveras Reservoir, which covers an area of about 800 acres, including the scattered Sycamores in the bottom of the stream, is very much less work than the clearing would be in the Peninsula Reservoir site, and it is costing about $30 an acre. It is impossible to say what that completed cost will be, because it is only partially done, but as near as we can tell, it is running about $30 an acre on the basis of a 10 hour day, and $2.50 a day. In my judgment the clearing of the side hills in the Pilarcitos Reservoir will cost about 15% more than the cost of clearing the Calaveras-Sunol road. The application of 15% to the cost of the Calaveras road on the basis of an 8 hour day, would make that about $75 an acre, so I have adopted $75 an acre as the cost of the side hill work on the Pilarcitos Reservoir. The clearing in the bottom, because it is less inconvenient to do the work, I think will cost about 20% less than the side hill work, which would give us $60 an acre. I have taken the average of those two figures $67.50 as the cost of the clearing of those reservoir sites. The area given here, 125 acres, is not the entire area of the reservoir, but only that part was believed to have been cleared, and the $67.50 applies to that.

In regard to stripping, from similar work I have done, I believe that is worth about 45 cents a yard to which I have added 5% for plant. I have included 5% for the use of the plant, machinery and the like of that, for that Pilarcitos work, not putting a plant

charge on the clearing or on the rip-rap. Stripping the borrow pits; where we obtained gravel for the Calaveras work it cost on the basis of a 10 hour day 22¼ cents, which is about parallel or equal to the conditions as I can see them here. That is for the flat part of the work, not the hill side. Adjusting this to an 8 hour day, it would make 28 cents per cubic yard. This would apply to 9,000 yards; that is roughly 1/3 of the 27,000 yards given in the schedule. That is an approximation on my part. I believe 1/3 is in the bottom, and the other 2/3 on the hillsides. Stripping the side walls would be done gradually as the embankment came up, and would be done by hand and dump wagons placed in the lower portion of the dam. That is, I mean the down-stream face of the dam. I do not know whether that was done with the original dam or not, but in my opinion there would be no objection to putting that material in the down-stream half of the dam, so that this work I estimate would cost about 55 cents a yard, including the excavation by hand, and the haul to the down-stream toe. In 1913-1914 the cost of haul-
4967 ing material from the steam shovel at Calaveras amounted to 11½ cents a yard, on the basis of a 10 hour day, or adjusted to an 8 hour day, it would make it 14 cents. The haul of 100,000 yards in round numbers that is being hauled now at Calaveras from the steam shovel to the toes, with an average haul of perhaps 500 feet, is costing nearly 19 cents a yard—18.8 cents. The loosening the load by hand would cost about 41 cents. Adding this to 14 cents, gives us 55 cents for that portion of it, so we have the bottom part of it 9,000 yards at 28 cents, which is taken out, and 18,127 yards, which is put into the lower part of the dam at 55 cents, a total for the two of $12,490, or an average of 45 cents per cubic yard, to which I have added 5% for plant, making it 47 cents.

I have also made an estimate of stripping this dam site by the hydraulic process, that is assuming there would be water enough at Pilarcitos to carry on this work, which, in my mind, is a very doubtful question. Figuring that you could work for about three months of the rainy season, and that there would be enough water passing Pilarcitos in an ordinary year for sluicing purposes, and using a plant similar to that we had for the sluicing of the Freeman dam site at Calaveras, and starting at a basis of cost at Calaveras of a 10 hour day at $2.50 a day, a basis of 22 cents, I figure that the bare stripping with water, which would leave it in a very ragged form, would be about 49 cents a yard; to this would have to be added 2 cents for hand work in evening up the raggedness, so you would have from 50 to 54 cents expended there for the side hill work; the center work would be handled in the same way as before, because there
4968 would be no place to dispose of it if the stripping were done by the hydraulic process, and there would be on the lower part of the sides accumulations from the dripping by the hydraulic process, because

the flumes carrying the material would have to have a grade from the down-stream toe up into the dam. I adopted the price of 47 cents for that excavation for stripping the earth. In the embankment of the 336,000 yards I have had in mind figures on other works and dams in this vicinity. The Drum forebay was finished in 1913 by the Pacific Gas & Electric Co., and was done in very much the same way that these dams have been built.

Questioned by Mr. Searls.

My source of information is Mr. Martin, who is the superintendent on the work, and who kept cost records, and these were given to me by him.

Questioned by Mr. McCutchen. 4969

I have known Mr. Martin for a number of years, and I know that he is a very dependable man, and all I can say is that this is what he gave me himself, and it was given me at 74½ cents a cubic yard. The Drum forebay is near Emmigrant Gap, below Lake Spaulding. The water from Lake Spaulding comes along the side-hill there, and where they drop it down the ridge to make the power they have created a forebay, which has an artificial earth embankment all the way around. It was built, as I understand these dams were built, using the same care in rolling, sprinkling, and picking out roots, and selecting material, and getting the very best job they could in order to have it water tight, having in it something like 275,000 cubic yards. I thought it was a job comparable to this work. 4970

I also obtained from Mr. Martin the cost of the Lake Valley Dam, an earthen dam built by the Pacific Gas & Electric Co. in that same region and in that same manner. That cost 80 cents a yard in place. The Lake Arthur Dam, which is in the same system, cost 76 cents a yard. In addition to that, I have borne in mind the cost of the steam shovel work at Calaveras that is now going on. That is costing about 53½ cents a yard, put in without any rolling or sprinkling. It is soft material, and a good deal of it would be used in Pilarcitos and San Andres, and the borrow pit would have to be opened, assuming it would be accepted. I also had in mind a dam that I built in Imperial Valley; not a very large dam, 75,000 to 100,000 cubic yards, across the Alamo River, and under the wage schedule down there it cost 48 cents a cubic yard, 10 hours a day, and $2 a day for labor. That was a Fresno scraper job.

Questioned by Mr. Searls.

That is the one that I built myself. There is not nearly so much rainfall there as at Pilarcitos, and you can work nearly all the year 4971
around without having the rain interfere with you at all. It is hotter in Imperial Valley and dryer than it is in Pilarcitos. While it is hot and uncomfortable, the heat is not as bad as would appear

from the temperatures you have in reading the degrees. In the summer time it interferes to some extent with the efficiency of labor, but there is part of the year down there that is not summer.

Questioned by Master.

We built this dam in the spring and early part of the summer, and I should say there was perhaps a quarter or a little more that was built in the heat of the summer; the rest of the time was very comfortable. I also have the Dry Canyon Dam, the Los Angeles Aqueduct, the North Haiwee, and the South Haiwee, with prices ranging from 37½ to 41½ cents a yard.

Questioned by Mr. Searls.

That information is from Mr. Clemens, the cost man of the Los Angeles Aqueduct, and those prices were obtained from the direct charges, plus the auxiliary charges over the whole works, which was 33.8 percent. They were not overhead, but auxiliary charges, and
4972 must be so rated in the work. The Dry Canyon Dam was 31 cents, plus 33.8 percent, which I have called 41½ cents. The North Haiwee, a very small and low dam, 19 cents plus 33.8 percent, making 25½ cents. The South Haiwee, 28 cents plus 33.8 percent, making 37½ cents. Four hydraulic fills that I have under construction at the present time for the Modesto Irrigation District, which are being done under contract, the prices range from 23 to 25½ cents. They range from about 65 to 95 feet high, are short, and very favorably situated for the work. Those are fills to carry permanent structures, and are not intended to be water tight. That simply represents handling material. The sluicing out on the Calaveras Dam runs about 27 cents a yard. In the Morton fill of the Modesto Irrigation District, which was a combination of hydraulic fill and machine work, the machine work cost about 60 cents a yard, and the average over all was 39 cents per yard. I have in mind the dams that surround the so-called Dallas-Warner Reservoir of the Modesto Irrigation District; they were put in by cars at contract at 45 cents a yard.
4973 At the present time, I am spending nearly as much as the dams cost originally, in order to make them water tight.

With all those figures before me, I estimate the cost of the embankment part of the Pilarcitos and San Andres Dam at 70 cents a yard, including the 5% for plant. I made estimates independent of that, and practically checked, reaching a figure of 64 cents a yard without plant charge. If steam shovel were used, and went right into the bank, similar to the bank at Calaveras, and assuming that the material would be satisfactory for the dam, and also by using plows and scrapers, and getting the material from the borrow pit, as I understand it was gotten at the time the dam was built, 66 cents per yard, and with the 5% for plant, it makes 69 cents, and so I called it 70 cents. In some of it I used 8 hours, and $2.50 as a basis.

Questioned by Master.

The cost at Calaveras was 27 cents for sluicing, and 53.4 cents for steam shovel work. That is actual cost on a basis of 10 hours a day, at $2.50 a day. When I have given the other comparative costs, I have given them as they were recorded. These are my estimates of the way I would build the dam, used as a check against what my judgment would be as to the cost.

In my figure of 70 cents, that involves the method of separating 4974
and selecting the material, using the best material for the front face, and a puddle core the same as was used, and use the rougher material for the down-stream face. I made an estimate of using scrapers and plows, and also of using steam shovels, and the two check out very closely to the 70 cents. You have to bear several things in mind in regard to a steam shovel up there, and I am not sure that you can use a steam shovel, although I have assumed that you could. It is in a territory of high rainfall, and the hills have naturally been denuded, so that wherever they are exposed, there is very thin skin. That is the reason particularly why even with impounding water you could not use the hydraulic method. You would be moving your equipment all over the country, and it would eat up costs so quickly that it would probably be more expensive than doing it by this method. I went over the ground and saw the borrow pits that had been used, and following that method, and on that basis you would use plows and scrapers, and by using plows and scrapers I rounded out the price that I gave. Then I assumed you could use a steam 4975
shovel, without being satisfied in my own mind that the banks were there. I assumed that with a steam shovel there could not be much selection. I assumed sprinkling and rolling in both instances, and put that in as a separate item.

In the first place we had a full embankment of in round numbers 337,000 cubic yards after it has been packed. This material in the embankment will occupy a space in my judgment 10% less than it occupies in nature in the borrow pit, so that the yardage to be removed is really 370,000 instead of 337,000, of which 18,000 would come from the stripping; then 6,000 more would come from the cut-off trench, which would be put in the lower toe of the embankment. This would make 346,000 yards to be brought from the borrow pit. A borrow pit is a place where you get material. It is not necessarily outside of your dam site, but in this case I have taken it from out-
side. If you use the plow and scraper method, you use Fresnos for 4976
loading the material by traps into dump wagons; from similar work at Calaveras, after changing to an 8 hour day, this would be 28 cents a yard. As a comparison with that on a basis of a 10 hour day, similar work at Calaveras costs 24½ cents a yard, and changing it to an 8 hour day, would make it 30½ cents a yard. The wage schedule at Calaveras is $2.50, and it is not a matter of changing

that. It is simply a matter of changing the hours. I have used 28 cents as that figure, although the Calaveras work comes to 30½ cents. The average haul from these various borrow pits would be about 1200 feet. The first 300 feet would be 14 cents. To that there would be added an overhaul of 900 feet; allowing 1 cent per cubic yard per 100 feet of that, it would make a total of 23 cents for the hauling. The hauling at Calaveras now is costing 18.8 cents on a 10 hour day basis, with an average haul of about 500 feet, which with the difference in haul is comparable to the 23 cents I have used. After getting it there, you would have to spread it, roll it and water it, because the dump wagons would leave it in windrows, and you would have to have a grader working it there, and then a sprinkler and a heavy roller; that rolling, watering and sprinkling would cost about 15 cents a yard, which makes a total made up of the following:

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Loading at your borrow-pit	28 cents.
Haul to the dam	23 "
Spreading, etc.	15 "
Making a total of	66 "

to which I have added 5% for plant, making 69 cents for 346,000 yards. Reducing that to 336,900 yards, it would be that proportional part of 69 cents, which would make it 71 cents. That is a check on the 70 cents that was used.

If a steam shovel be used, you would have to get it in there, and it would cost as follows: To load the shovel in San Francisco, $100; unloading at Millbrae about $100; 7½ miles of transferring over that hill, about $200 a mile. The transfer of a steam shovel from Milpitas to Calaveras over a very good road, very much of which was flat, cost $110 a mile, and this is nearly all hill, and very much more difficult to get in than the Calaveras road. After you get it in there, it would cost you $100 to assemble it, and $50 more to get it into place. Then you would have an additional charge for crossing the State Highway, and for fixing the bridges, because none of them would be strong enough to carry a steam shovel. I estimate that the crossing of the State Highway, and the fixing of the bridges would cost another $1,000, making a total cost of $2,650 to get it in there. Spreading that over 337,000 yards, it would be

4978

about ¾ cent a yard. The first steam shovel that was taken into Calaveras in 1913 cost about $110 a mile. Moving it after the season of 1913 to go to the work in the season of 1914, it cost something like $1,000 a mile, because it had to cut its way. The distance from Milpitas to Calaveras is 9½ miles, but you have a comparatively smaller amount of hills than you would have going into Pilarcitos. Under similar conditions in Calaveras, it was necessary to have 11 teams and wagons to dispose of the material. They handled about 450 yards in a 10 hour day, and reducing this to an 8 hour day,

it gives 360 yards. It was a Marion Model 35 shovel, a yard and a quarter dipper.

Questioned by Mr. Dockweiler.

The swing necessary to make when it loaded the wagon depends entirely; sometimes it would make a swing of a quarter of a circle. As a matter of fact, you cannot get by with much less than a quarter of a circle, because the mules won't go near the dipper. That shovel 4979
could make a complete swing. It was a merry-go-round. If the material were very hard, the Model 40 Standard would load quicker; if the material had been shot away and was soft, it would be about the same.

DIRECT EXAMINATION BY MR. GREENE.

The cost of operating this shovel would be $144.22 a day, so that at the rate of 360 yards a day, it would be 40 cents a yard. The cost of the shovel work at the present time in the borrow pit at Calaveras, with a 500 foot haul, is 37 cents, exclusive of blasting on a 10 hour day. On an 8 hour day basis, that would be 46 cents, as against the 40 cents that I have above. Adding to this the spreading, rolling, and sprinkling, 15 cents a yard, and 8 cents for blasting, we have by the scraper method 66 cents a yard, and by the steam shovel method 64 cents a yard. Add 5% for plant, it will give us 67 cents and 69 cents, which I have used as a check against the 70 cents which I have. I did not make any allowance for getting my steam shovel out, because that would depend on how you would do the work. That steam shovel in the order of things would go from there to San Andres on the way out, and be charged to San Andres. I have used the same unit price in both places. If you try 4980
to build the two dams at the same time, then you would have to add to that the charges of bringing out the shovel.

Questioned by Mr. Hazen.

You could not build dams as big as those with one shovel. The probability is that in order to beat the winter you would put more than one on.

DIRECT EXAMINATION BY MR. GREENE.

The cutoff trench, as I get it from the plans, is about 12 feet wide, and from 20 to 40 feet deep. The material is classified as loose rock, and I presume from the adjacent country that it is broken up formation similar to what we have all through these Coast ranges, and that it would have to be shored in order to hold up safely during the progress of the work. I have before me in this connection the cost of cutoff trenches in various dams. On the Dry Canyon Dam on the Los Angeles Aqueduct, built in 1910-1911, the cost clerk, Mr. Clemens, gives a price at $4.07 a yard, to which should be added 33.8 percent for pro-rated auxiliary charges, making a cost of $5.43 a 4981
yard.

Questioned by Mr. Searls.

They may call the 33.8 percent overhead. It has been called all sorts of things. Mr. Mulholland objects very strenously to this being called overhead. It is largely composed of expenditures that must be pro-rated over the work. I don't know whether any other percentage was added for the purpose of ascertaining the cost of the work. I never have seen a complete analysis. I don't know what the Los Angeles aqueduct has called its overhead. I can give you the class of items that enter into the 33.8 percent if that will be of any service to you. I will get them later.

DIRECT EXAMINATION BY MR. GREENE.

4982 The South Haiwee Dam, which had a deep cut-off trench, although very little water to contend with, the cost given by Mr. Clemens is 2.58 per cubic yard, to which I have added 33.8 percent, and that becomes $3.44 per yard. This trench is timbered throughout.

The North Haiwee Dam, which, as I recall it, was simply a scraper cut-off, and no timbering. The cost was 34 cents a yard.

In the Modesto Irrigation District we have just let a contract for making these dams water tight. I told you of them before. Part of the work is carrying down a cut-off trench at the front toe of the dam. The contract price on the deep one, which has a maximum depth of 55 feet, is $4 a yard. The contract price on the other one that is from 2 to 10 feet deep, is $1.50 a yard. Neither of those are in rock. They are in sand, the deeper one having some water in the lower part of it. The shallow one has been completed. The deep one is about to be begun. That is just for the excavation. It is the trenching, just loose rock. It varies in width according to the depth from 2½ to 10 feet, cut vertical, and it includes the cost of support-
4983 ing the sides, which does not include the cost of the concrete or the refilling.

I have assumed here that these sides will have to be supported. That is the assumption that I make in these trenches. These trenches are about 12 feet wide, and from 20 to 40 feet deep. I think, for that character of material it will be necessary to support them. The cut-off trench in the Calaveras work, which is considerably different, is a matter of removing the soft broken rock; we put a trench there 25 feet wide, and about 8 feet deep into this soft rock. The material was blasted and removed by wheelbarrows and cars, and nothing re-handled, because the depth was only 8 feet, and the material was dumped into the main body of the dam; that is beyond the central portion, as I have assumed this will be. The cost there on the 10 hour day basis was $1.93 a yard. Of that cost about 80% was labor, or $1.54 was labor. If we adjust this to an 8 hour day, we have a cost of $2.32 a yard. In a deep and narrow trench the excavated material would probably have to be handled by derricks, or probably

rehandled several times by hand, and you would have the interference of water, which would probably be a pretty large amount in the Pilarcitos country. These conditions, I think, would add about 70 cents a yard to the cost as given above, which would make it a cost of $3.02, or say $3 a yard, to which with 5% added for plant, would give $3.15 a yard, which I have used in this estimate.

The next item is the puddle, which is made of clay, and from all that I have been able to learn, was obtained from several places, mostly in the case of Pilarcitos from the bottom of the reservoir, and in the case of San Andres from one place and another as the pockets were found throughout the surrounding watershed. In order to obtain this, I have made an estimate. I have not had the advantage of 4984
having built puddle cores as Mr. Hazen described in his early work. The puddle work that I have done has been in connection with putting in structures in order to make them water tight. I have, however, the contract price that was paid by the Modesto Irrigation District, the puddling between the walls of the canal that they built for about a mile, which was $1.60 a yard. I worked out here how I thought the cost could be made up. In the first place, the top soil would have to be removed for an estimated depth of about a foot in order to get rid of the humus and the undesirable material. Assume that you have a 6 foot bank to work on. That would be at the rate of 1/5 of a cubic yard for each cubic yard of clay that would have to be removed and spoiled off to the side. This excavation would cost about 28 cents a cubic yard of top soil, or 6 cents a yard for the clay that was put in the puddle pit. We tried to handle some clay by one method and another at Calaveras, but we found it was necessary to blast it in order to do anything with it. I figured that the blasting of this clay up there would cost about 10 cents a yard. The cost of blasting at Calaveras was 8 or 9 cents a yard. Then in addition to that the clay would be available in large lumps which would have to be broken with mauls or other method in order to be laid. I estimated that that cost would be 15 cents a yard. They would be loaded probably in traps, which would make it 28 cents a yard. The haul would be about the same as the haul used in the embankment, 23 cents a yard. Then would come the puddling, the ramming, etc., which would be about 50 cents a yard, so that we get as a total cost $1.32 a yard, which, with the shrinkage of 10% would make it $1.45, and 5% for plant, makes $1.52, which I have used in this estimate.

SEVENTIETH HEARING. DECEMBER 1, 1915.

Witnesses: F. C. HERRMANN for Plaintiff.
N. RANDALL ELLIS for Defendants.
ALLEN HAZEN for Plaintiff.
GEO. L. DILLMAN for Defendants.
J. H. DOCKWEILER for Defendants.

4986 DIRECT EXAMINATION BY MR. GREENE.

(Certain corrections noted in the record).

The next item of concrete in puddle trench I have taken at $12 a yard, with 5% additional for plant; simply my judgment of
4987 what that would cost without going into any detailed analysis.

The next item is rip-rap loose, which I have taken at 10 cents a square foot as a price, which in my experience I think is warranted.

The next item, benching old dam for additions; I have made no allowance whatever, because I consider that this dam was to be built to the height that it is now in one operation. I used the same unit prices that are given here for the San Andres Dam, and for the small dam called the clay dam, feeling that those unit prices were applicable to that territory, except in the case of the San Andres Dam where the rip-rap is, I consider a very much better class of work than the other, so that I put that in at 15 cents a square foot, as against 10 cents for Pilarcitos.

Questioned by Master.

I do not think it is what Mr. Hazen termed paving yesterday, but it is a smoother job than the Pilarcitos, and to my notion, more labor was expended on it, so that in reproducing it as against the other it would be 15 cents, as against the others at 10 cents. It is not laid flat in the way you speak of the Howard cut paving. In the Howard cut there is no cement between the joints. They may have brushed a little grout in, but that work on the Howard cut is more expensive work than either of these two.

4989 Questioned by Master.

As regards the matter of prices, Mr. Hazen's and my idea may be similar, but I have not seen Mr. Hazen's prices, and I do not know whether he would explain it in the same way I would or not. It seems to me if we took the time out of ours to go through and pick out the differences where they are material, it will save considerable time on the part of everybody. I have not compared my figures with anybody's, so I do not know what the other figures are.

DIRECT EXAMINATION BY MR. GREENE.

The cost of moving the second steam shovel, No. 41, from Milpitas to Calaveras, was $1,900, as near as we could get it, and that is

at the rate of $200 a mile, figuring it 9½ miles. These dams as they 4990
are, are as fine examples of earthen work as I have ever come across anywhere in any earthen dam, and I have visited a great many all over the country. There is no question but what great care was used in their construction, and the fact that they are so tight, and have shown so little settlement, and have gone through earthquakes like that of 1906 without destruction, shows that they are remarkable structures. In my opinion, they are as fine earth work as you can get. At the time they were built they were the highest dams, and were daring engineering in that way, and by reason of the fact that they were so high, great care must have been taken. The Pilarcitos was built in 1867, and the other one in 1872.

Questioned by Mr. Searls. 4991

I have not known anything about any trouble with the Pilarcitos Dam. As I recall it, it was not necessary to run a tunnel through the dam to find a leak, but there was some leak in the rock itself, not in the dam; it had nothing to do with the dam. The leak was not in the structure itself, but rather on the hillside supporting the structure. In a similar way the leak at present is around the end of the Haiwee Dam. It has nothing at all to do with the structure, and casts no reflection on the character of work in the structure. It is simply one of those things that take place in the foundation of the 4992
work, where you have geological conditions of this sort, and will only develop when a high head is put against them on that side.

Witness: N. Randall Ellis for Defendants. Ellis

CROSS EXAMINATION BY MR. GREENE. 4994

My experience with trenches relates to trenches ranging from a minimum of about 3 feet up to a maximum on some of our penstock work of 16 to 18 feet. The smaller trenches probably range from 3 feet up to 5 feet, and I do not recall any intermediate trenches of say 10 to 12 feet, but there were larger trenches from 15 to 18 feet in width. I have not been engaged in laying trenches in outside roads, but have had trenches in street work in cities, and through tracts before roads were finished. Normally, those trenches were not less than 3 feet ordinarily, in width, but in city work I think the width ran up as high as 4 and 5 feet.

I do not know that I could make a comparison of costs per cubic 4995
yard between the 3 foot trench and the 5 foot trench, referring only to width. The function that affects trench work more than the width, ordinarily, is the depth. That seemed to be more of an influencing element in all my trench work than width. If you were to have one trench 3 feet wide, and the other 5 feet wide, but both of the same depth, the excavation for the 5 foot trench would be somewhat more

expensive. The casting is harder in a wider trench than in a narrow trench; the whole operation is pick and shovel work, with the depth as one influencing feature. As the mucker goes down in the narrow trench he is casting on to a bank. You do not have to put the man on top shoveling back at as low a depth with the wide trench as with the other trench, or with the shallow trench as with the other trench; specifically, you will probably, in shoveling a 3 foot trench, work on down to somewhere between 3½ and 4 feet without having the labor service on top, but with the wider trench, you possibly have to put the service on top a foot shallower, as one influencing effect. The question of sloping would have some effect; in sandy work sloping is
4996 often resorted to instead of timbering; in other words, instead of attempting to maintain vertical sides in sandy soil, to cut out the timbering, you can throw back a slope which means the removal of more material, and that possibly would enter as a cost element slightly more into the wider trench than into the narrower one. I have not considered it just from that standpoint, because in figuring the average trenches, I have figured trenches ranging from 3 to 6 feet.

In highway work, the question of not taking up too much of the road would enter into the matter to a slight degree. We had the same condition on sewer excavation in lower Market Street, maintaining traffic in the center, and digging trenches on both sides of Market from Second to East and Front Streets, and the care of the spoil was somewhat more than would be involved if we were trenching in the open country. In other words, you are possibly confined to a more or less absolute width for placing the spoil. If your trench is wider you would crowd on up, and probably take more care in getting the spoil away, or taking care of it on the bank. The actual result is having
4997 additional men on the work to keep the spoil within certain limits. The same principle would apply on State Highway work down here, and I so considered it in making my estimates. On the State Highway work I figured that the average work, excluding the extra difficulties that were encountered, would have averaged 65 cents. I took the extra expense along the State Highway, and reflected it into the total yardage all over the system, or in other words, I allowed 5 cents over the complete yardage, which amounts to 570,000 yards. If I took that cost and applied it simply to the yardage along the State Highway, it would mean an extra of about 25 to 27 cents per yard. I think that I allowed absolutely on yardage involved all along the State Highway. In other words, the yardage in the State Highway was probably something under 20% of all the yardage on the work, and if I allow 5 cents additional over the entire yardage over the pipe lines of the Spring Valley, then it is practically equivalent to 25 or 26 cents a yard extra as an absolute extra addition to all yardage in-
4998 volved on the State Highway. My figure at 25 or 26 cents a yard would probably figure about 40 cents a foot as comparable with Mr.

Hazen's 75 cents a foot. I think the average yardage per foot along the Highway work, that is taking 54 and 44 inch, is about 1 2/3 yards to the lineal foot; the 54 I think is about 2 yards, and the 44, 1½ yards. That would make mine about 42 cents a foot, as against Mr. Hazen's 75 cents a foot, and my base yardage, 65 cents, as against Mr. Hazen's 75. I reflected the 40 cents a foot, and averaged it, and made it 5 cents a foot over all. My figure of 42 or 43 cents is comparable to Mr. Hazen's figure of 75 cents.

Witness: GEO. L. DILLMAN for Defendants. Dillman

CROSS EXAMINATION BY MR. GREENE.

I looked up that Portland crossing, and the per foot cost of the 1894 construction was $37.67 for a 28 inch pipe; for a 24 inch pipe it was $20.94, and for 30 inch pipe $33.48 per lineal foot. I was wrong in mentioning the 24 inch pipe as the second Bull Run pipe. It was the 1910 pipe that I talked to Mr. Clark about, in 1914. This talk 4999
was prior to the publication of this paper, and I think undoubtedly I should have referred to the 1910 pipe—30 inch—instead of the other pipe. The 1910 pipe had a very large item for dredging—$20,000—which seems abnormal, and is, to a considerable extent; it is about 3 times the amount used for dredging for the 24 inch pipe, and it may have been accounted for by the method of doing work, which added expense without getting results. The description shows that they moved a suction dredge on and off this work, which, if it is charged to the work, is an expensive thing, and if it does not do much work, it might account for that very large dredging expense, so, reducing that to the dredging for the 24 inch pipe, the dredge cost should be reduced about two-thirds, or $13,000. That would make the dredging cost of the 30 inch pipe $27 a foot, applying the formula which I announced would make a 16 inch pipe cost $7.68, a 22 inch pipe $14.52. There is an added saving in our construction over that, because the two pipes are laid side by side, and practically the same dredging would do for two pipes that in the Portland case does for one. I do not know how hard the material is, but the dredging in the case of the Dumbarton pipes is very much less than the dredging at the Port- 5000
land crossing. I do not think you would have to hold a dredge at the Dumbarton crossing while both pipes were being laid, as I am not sure but what the pipe, if the trench did fill up—it would not interfere much with the pipe settling. I get the figure of $27 a foot by taking the cost of the 30 inch pipe as given $33.48. The steel pipe costs $29,135. The dredging, which I have reduced two-thirds, was put down originally at $20,318. The pipe laying of the flexible joint pipe is $9,211.50. (Do not reduce that dredging). That is a portion of the item in the summary of $65,000, which gives the cost of the

submarine pipe, and divided by the length, which is 2,047 feet, gives a cost price per foot of $33.48. The labor and engineering is a small item, and the engineering is accounted for by an addition afterwards, and so that should not go in. I do not know just how the rest of the item, $4,800, should be divided between the cast-iron pipe and the
5001 submerged pipe. There is nothing here to show how much of the labor belongs to this pipe, and how much to the other pipe, but I consider that that was covered in engineering and contingencies. This table takes in one pipe; it is partly a flexible pipe, and partly a cast-iron pipe. This labor can only refer to the items that are in there as Table 4. What goes into trench excavation, cast-iron pipe, valves and specials, I do not know.

Questioned by Mr. Hazen.

There were 2,047 feet of submarine pipe, which cost per foot $33.48, and the total cost on that calculation was $29,135, $20,318, $9,212. The whole cost of the work was $120,008, and that cost covered the submarine pipe and the land pipe, the extras and specials,
5002 but nothing else. The trench excavation for the land pipe cost $5,135. The cast-iron pipe in place cost $25,148; the valves $2,306; concrete in gate chambers $708; specials $2,638; extras, labor and material, dock repairs, $10,198; labor and engineering $4,808. That makes $51,000 in round numbers. The land pipe was 2,265.6 feet in length, and cost per foot $11.10. I am only reading this estimate; I am not testifying as to that. Here is the statement given as the cost of this pipe, which included the submerged pipe, and some cast-iron pipe. I do not think the details can be segregated, but the summary can be segregated exactly, and I took that. My figures are based on that, but I am free to confess there is a discrepancy in these figures, that is, in the details and summary of this book. I do not know which is right. Assuming that the one that is lowest is right, I do not know how much we have for the land pipe, and how much for the water pipe. I did not judge the land pipe. We have $33.48 for the water pipe.

Mr. Metcalf: That does not correspond to the three items which you gave us; $33.48 times the length, 2,047, would be in round num-
5003 bers $68,700, and the three items which you gave us added up only $58,700.

Questioned by Mr. Hazen.

I do not know just what the conditions of making land connections were. I have not thought anything about that. I think those three figures I have added, the cost of ball and socket joints, as being a part of that $65,000 item, in the summary. That is an item of $10,350. I have evidently made the inner cost of the submerged pipe $33.48, and of the land pipe $15.50.

Mr. Metcalf: The three items which you gave me on the submarine pipe add up to $58,665; that amounts to $28.60 odd per foot.

If you added for ball and socket $10,000, it would bring it up to the $33.48 which you first stated. If you did not add it, the cost of the land section, according to the figures which you gave, would be $22.50 per foot. If you did add it to the submarine, and then deducted it from the land figures, it would leave the land figures $18.10 per foot, instead of $22.50; in either of them it leaves an unaccounted for difference of $11,000, which on the total length of 4,313 feet would be $2.55 per foot. 5004

Mr. Hazen: The figure I used on the Portland job was about $45 on an approximate separation. In reaching that, I deducted $25,200 for 2,266 feet of land pipe from $120,008, leaving $94,808 for the crossing, which amounted to $46.50 per foot, and I recognized that that was an approximation, and told you about $45. The trenching goes into the submarine. If that is for the land pipe, 5,705 cubic yards, at 90 cents—it states above that the price of $11.10 was for the price of plates—I assumed that included excavation, but I may have been wrong about that. The valves were $2,360, and were at the ends of the submarine pipe, and should be excluded.

The other items are for extras, labor, material, and dock repairs. I should think that ought to be included. Taking the cost of pipe laying as $114,723, which excludes the engineering and labor items in the lower table, and deducting therefrom the first items for trench excavation, the second item for cast-iron pipe in place, an item for valves, an item for concrete in gate chambers, an item for specials, a total deduction of $35,987, leaves a net of $78,736, or $38 and something per foot. I think that $10,000 extra item was principally on the submarine work; perhaps a small part of it should be deducted. That is a surmise from the title of the figures. 5005

The Master: That $10,000 item that Mr. Dillman threw in to the land pipe, Mr. Hazen has thrown into the submarine pipe, and it would make about $5 a foot.

Mr. Metcalf: There is another item; $4,808, that Mr. Dillman threw into the land pipe.

Mr. Hazen: I cast that out entirely in order to get my figure.

The Master: All of which goes to show Mr. Clark has not got up his figures in very good shape. 5006

Mr. Dillman: All statistics of this kind, and of every other kind that I know of, are partial, and a man starting with partial statistics, can, by the selection of items, apparently prove anything he wants to prove. While statistics have great respect paid them it is entirely beyond their desserts. I have taken these figures and shown by plausible assumptions that my figures of $7.50 on 16 inch pipe, and $13.50 on 22 inch pipe, are reasonable from my standpoint, not because of statistics and deductions, but because I believe and know to such an extent that such a thing can be known that I could lay those submarine pipes at that price.

CROSS EXAMINATION BY MR. GREENE.

Taking the 24 inch pipe line, it does not check my figures. I get $9.30 for the 16 inch, and $17.70 for the 22 inch. The steel market
5007 at that time was fairly low, but I do not know whether it was lower then than it has been at any other time. I do not know the depth of the water at the Portland crossing for the 24. It was deep enough for navigation, and I think that in the deepest place at Dumbarton it was deeper than that, but the average depth is probably greater at Portland than at Dumbarton. I do not think the average depth, except in the matter of divers, makes a great deal of difference. If the same method of laying was used, it would make a slight difference whether it was 10 feet or 50 feet in depth. I suppose the wind would average a little higher throughout the year at Dumbarton than at
5008 Portland. Both places have long periods of fair weather, but there is a great deal more rain at Portland, and if the work were done in a rain storm, it would be somewhat impeded. The Portland crossing is much the shorter crossing, which would make the average cost at Dumbarton less. I do not think the difficulty in securing machines, or the length of the cable required, would have any effect upon the cost at Dumbarton. There is no difficulty about obtaining cables. It is possible that you might have waves that would stop your work a little while at Dumbarton, but if you selected your time of the year, they would not. Of course, if you did not have your scows properly kedged, the waves might result in some difficulty in keeping your
5009 scows in line. Even though the scows were properly kedged, storms do occur down there at certain times of the year which might make it a matter of great difficulty to keep them in line. I have seen wave action in Portland Harbor that would probably throw your barges out of line, but not to the same extent that you would find it in Dumbarton. The scows at Portland would be moored to kedges up and down stream, and to mooring piles on either bank. At Dumbarton the crossing is longer, and you would have more kedges, and less shore action than at Portland. It would not necessarily be any more expensive, if a man properly understood marine equipment and ground tackle; if he were doubtful about it, it might cost a great deal more.
5010 I am considering expert handling of marine equipment, and no storms or wrecks in both cases.

Questioned by Mr. Metcalf.

So far as the tidal currents go, they are no more to contend with at Dumbarton than the wave currents at Portland; so far as the winds are concerned, I would expect and prepare for them, and cause extra expense for those precautions at Dumbarton.

DIRECT EXAMINATION BY MR. SEARLS.

5011 I have never built a high earth dam. I have seen the construction of the last lift on the San Leandro Dam, and was consulted in re-

gard to the construction details there, but about the cost I have no data. I do not think it would be comparable if I had, because that work was carried on in a very expensive way. The work was in charge of a man who was extremely careful, by the name of Orestes Pierce, and I think he was right from his viewpoint. I remember something of the plans and specifications on an earth dam, on which I computed the bid, I think it was Wild Horse Valley, for the water supply, for the storage of water for the City of Vallejo. I bid on that work, and the specifications were quite stringent, for about 30 cents a yard. I was not the low bidder, and did not get the work. That was in 1894. This work was for all of the dam construction, and it had to be sprinkled and rolled in thin layers, and my recollection was it was 35 or 40 feet high, and maybe more. I studied the question of dams, including earth dams, more for the purpose of understanding general principles concerning them, than to get at the mere cost. Every ditch bank to the extent it is a fill, is a dam. Every levee in the delta of California is a dam, and intended to act as such. The 5012
higher the dam is, the more dangerous the result of failure, and therefore, greater care must be taken with greater heights. The mechanical operation of making the fill, just as in any other fill, consists in loosening the material, in loading it, in hauling and dumping it, and subsequent treatment. It does not make any difference whether it is a dam or railroad fill in some of these particulars. I have seen the San Leandro Dam, and the La Mesa Dam which is in San Diego County. The first Woodbridge Dam they attempted to tighten with puddle, and I examined that after its failure, and made a report to the New England Trust Co. on the cause of its failure. The reservoirs at Portland have some dams in connection with them that I have visited. I have had experience in the building of levees, ditches, railroads, and general construction work. I have had experience in handling steam shovels, and scrapers, and other equipment necessary to construct these dams. I am more familiar with the cost of the work from the 5013
use of equipment than I am from the details of the equipment costs.

At the time I appraised the Spring Valley earth dams, I had the agreed inventory, and inspected the sites and dams a few times. The borrow pits were evident outside the reservoir. I did not have the history of the construction of these dams in mind, but I knew the materials that were in the dams, and the character of the core.

The clearing I have put at $50 an acre; I have seen clearing done all the way from $5 to $250 an acre, but this is moderately light clearing, with no exceptionally big trees evident, and should they have existed, they would probably be worth something as fuel, which would cover their extra cost. The most of the clearing is chaparral, and I have put $50 as a price, with a profit to a responsible contractor. Stripping the site of the dam is ordinary plowing and scraper work, and 25 cents a yard is sufficient for that work in that locality. The

embankment I have put at 40 cents a yard, which is sufficient for its excavation, loading, transportation, dumping, and some finishing. I
5014 do not regard the dumping in definite layers, and rolling with grooved rollers, or other devices, as at all necessary in this case, but I presume, from what I heard yesterday, that this was done. For most of my operations I used a steam shovel. There would be some scraper work, but the most of it would be handled and loaded with a steam shovel. I would expect to use 1½ yard buckets for that work, and would try and work up to approximately 1,000 yards in 10 hours, but if I got less than 600, I would be much disappointed. I figure that my average would be somewhere between those two points. There is no special difficulty about the material on the hillsides around Pilarcitos from the standpoint of excavation. I refer to the facility with
5015 which a steam shovel could work there. The material is suitable for continuous and ordinary operation of a steam shovel, and you would get plenty of material for the up-stream face of the dam, and the down-stream also. I would select my material, and put the finest on the upper side, and the coarsest on the lower side.

I would expect to use not less than 9 hours, and possibly 10 hours, for my working day, and might work night shifts. I would have to use the wages of the country, but I would not pay any more than I had to. I would pay a common laborer about $2.50 a day in 1913;
5016 possibly you could cut that 25 cents a day. There is nothing in the conditions about the bay which would prevent the handling of a crew on the basis of 10 hours a day, and a basic wage of $2.50 at Pilarcitos and San Andres. If you were to work there, you would have to have your men at a boarding house on the job, and that is far enough away so that you would have full liability of interference with I. W. W.'s. I have handled Mexican labor, and there is a proportion of the skinners that are very good; pick and shovel men, ordinary labor, will do pretty near twice as much as the Mexicans. I would not consider that in clearing work the Mexican labor would do as much on an average under Southern California conditions of climate as white labor would
5017 under the conditions you would find in Pilarcitos. I would not consider it a fair basis to attempt to estimate the cost of clearing Pilarcitos or San Andres sites in 1913 by taking the cost of Mexican labor in Southern California, and expanding it on the basis of an 8 hour day and $2.50 wage. I do not think it would be fair to take Mexican labor at $1.60 for a 10 hour day in Southern California, and to compare that with the cost of Pilarcitos by expanding it to $2.50 a day for 8 hours with white labor.

Witness: ALLEN HAZEN for Plaintiff.

DIRECT EXAMINATION BY MR. GREENE.

5018 There was a question as to the pipe bought from Francis Smith & Co. This is the only bill that has been found prior to the Pleasanton pipe, and it is for $1,880 worth of work, covering the making of some 3/16 and a little ¼ inch pipe from plates furnished by the Spring Valley Water Co. to Smith & Co. The price is $1 per foot for the 3/16, which amounts to 1.46 cents per pound; $1.25 for the ¼ inch, which amounts to about 1.34 cents per pound. Bends were first charged at $525, which amounted to about 35% of the straight pipe, but were afterwards reduced to $395, which amounts to about 27% of the price of the straight pipe. The bill is dated October 13, 1908.

Questioned by Mr. Searls.

The 3/16 is about the average for this pipe. The ¼ inch would not be much in excess of the figure $1.35, as given by Mr. Moebus. I think his figure included bends.

Questioned by Master.

5019 The first item is 1,186 feet in length, and cost $1800. It is a very small item.

Mr. Metcalf: We think the extension to which he refers in the city was the Chenery Street work on the San Andres pipe line, 30 inch No. 10, with lead joints, about 1850 feet long, laid in 1895.

5020 Mr. Herrmann: The pipe on the Chenery Street line is not under much pressure. It is light, and it just happens that the ground comes up near the hydraulic grade line there.

Mr. McCutchen: There is no criticism intended of the method of manufacturing that pipe.

5021 Mr. Hazen: This does not include dipping, and does not include transportation from the works along the trench; simply work in the shop; and in that respect is not comparable with the other figures we have.

Witness: GEO. L. DILLMAN for Defendants. Dillman

DIRECT EXAMINATION BY MR. SEARLS.

There is nothing in this inventory to show that this was a lagged trench, and I therefore assume that it was open trenching, and $1 a yard seemed sufficient for it. In constructing that dam, it is perfectly possible to use an open trench. You would probably excavate more material, but it is a question whether the extra trenching would cost more than the lagging. In making this estimate, I considered that it was an open trench. The trenching is in loose rock, and, therefore, I presume would stand very well without lagging. I did not consider 5022 whether there was anything in the cubic yardage given which would

indicate one way or the other whether that was an open trench or a lagged trench.

Mr. Hazen: I went through that with Mr. Lawrence, who had the plans, and they showed just how deep the trench was. I checked approximately the yardage on all these dam quantities, and they check with his work. I had that before me when I made the estimate, but I would not venture to say from memory now just what those conditions were. I think I assumed lagging in my figure of $2.50, because I thought it was necessary.

5023 Mr. Herrmann: The plans of Mr. Lawrence show that the trench is about 12 feet wide, and extended to a depth of about 40 feet in the maximum. I allowed for lagging, because I did not consider it would be safe without, and I considered it in connection with the unit prices for lagging. The diagram shows no batter, but does show a few set-offs. From the scale on these diagrams, I got a maximum depth of about 40 feet, and I figured it would not be safe at those depths, and
5024 that you would have to lag. I have seen nothing from the company that shows what method was used.

DIRECT EXAMINATION BY MR. SEARLS.

The next item is puddle, and I have put that at $1 a yard. There can be all sorts of money spent on making puddle. If pure clay is demanded, and the manipulation is by hand to a stiff consistency, such as was used on the raising of the San Leandro Dam, I do not know
5025 what it would cost, but it would cost something more than this figure. Good puddling can be made of clayey material containing a great many other things besides clay; sand added to clay increases its value as puddle, and decreases the danger of using poor clay. The real dam here is this core wall; the rest of the structure is to support and protect this core wall; the rip-rap is to protect that protection. The reason that I have estimated a low price, compared to some of the other estimates for embankment, is because it is not necessary to make the embankment impervious. If the embankment is made impervious, there is no need of puddle. If the puddle is impervious as is the dam, there is no need for that extensive work on the slopes.

Questioned by Mr. McCutchen.

The "extensive work" does not show now. It is the work that was put on the material that is there now, according to the estimates of Mr. Hazen and Mr. Herrmann.

DIRECT EXAMINATION BY MR. SEARLS.

For concrete in trench 300 yards, I have estimated $7.50 a yard; rip-rap at 6 cents a square foot, which amounts to $1.54 a square yard, and which, in my opinion, is sufficient for that rip-rap. Figuring it a foot thick would make it $1.62 a cubic yard, which is sufficient for this kind of work. Benching for extension I have estimated

as scheduled 25 cents. That is the ordinary team and scraper work, and is done simply to get a good compact between the new work and the old, and I have estimated it as such. I took into consideration, 5026
in reproducing this dam, that it had originally been built to a lower height, and then raised. I did that to the extent of $2,443 in this estimate. The clay for the puddle could be gotten by selection from the borrow pits.

In the Gatun Dam there was very little selection of material for puddle. There was a trench kept wet and saturated during that construction, the sides being brought up. Puddle is not always necessary in dams; there are many dams that are built without special puddle. The Holland dykes, which are the biggest lot of dams on earth, and are pretty substantial, are built out of pure sand. My figures on the San Andres are practically the same. The difference there is in more trenching, more friable material. I have assumed that that is earth, and I have made that 50 cents a yard for trenching, as against $1 a yard for loose rock. I base that on the fact that it has a wider trench for the amount of material, and because it did not specify the material, I assumed it to be earth, which loosens cheaper, and handles a little easier. I did not make an examination of the country there so as to determine the material, but I know that a great deal of it is earth. If they had gone down into loose 5027
rock, my figure here would be increased; that is, if it were hard material to any extent. There are no other units differing from the ones I used on the Pilarcitos Dam. There is a difference in the trenching, I figured the Upper Crystal Springs Dam at the same prices as at San Andres.

Page 3 of my estimate, clay dam on San Mateo Creek, $6,879. I didn't pay much attention to it, because I considered it an obsolete 5028
structure. It is not of any special value to the works. In that appraisal I have simply the one item, and I have put in the embankment at 25 cents.

Top soil, 2,450 cubic yards	$1,200
471 yards of trenching	235
7,000 yards of earth embankment, at 25 cents	1,750
1,200 yards clay puddle	1,200
310 yards of earth excavation in the spillway	78
Concrete in spillway, 132.8	1,062
26,000 feet, B.M., rough redwood	1,337
Gate house	75
16 inch gate valve	40
153 feet of 16 cast-iron pipe	490
Total	$6,879

The clay puddle is $1; concrete is about $8. The pipe price included the excavation and backfilling, so that was omitted.

5029 Witness: J. H. DOCKWEILER for Defendants.

DIRECT EXAMINATION BY MR. SEARLS.

I studied up the history of these existing dams; read over all the reports that I could get bearing upon their construction and design, and the testimony given regarding them by the officers of the company in various proceedings before the Board of Supervisors of this city. I am familiar with the testimony given by Mr. Schussler at the last trial of rate cases. I am familiar with the cost of earthwork construction, and the building of dams. I am familiar with the costs of Mr. Mulholland's work on the Los Angeles Aqueduct, the various dams built there, and the work incidental thereto, with the cost of excavating the puddle core trenches. I have studied the cost of the construction of the dam designed and built for the City of Vallejo, an earthen dam 92 feet high. I am familiar with the San Leandro Dam, which, up to a few years ago, was the highest earthen dam in the world. This dam was built in 1874. I am
5030 familiar with the cost to the Peoples Water Co. of building the earthen dam in the central reservoir, in the City of Oakland, during the years 1909 and 1910. I have read the literature on the subject of dams. I have read the testimony of the Pacific Gas & Electric case before the Railroad Commission, relative to the earthen dams of that company. It covered the Drum forebay, and several other dams.

Questioned by Mr. McCutchen.

Lake Arthur is one of the reservoirs of the Pacific Gas & Electric Co., in Placer County, I think. I have never been to Lake Arthur, but I have seen the Drum forebay.

Mr. Ellis: I have never been to Lake Arthur, but it is a small dam of about 70,000 cubic yards on one of the tributaries of the South Yuba. I am familiar with it only through one of the engineers who was on it.

Mr. Dockweiler: My first item is clearing reservoir site, 125 acres, at $40 an acre. This figure is based on contractor's figures for clearing work in the neighborhood of Woodside, California. I got that upon inquiry. I had an investigation made, and the infor-
5031 mation given me by the men I sent out on that was that that was the cost of clearing work in that vicinity. He said that was the ruling price for work similar to this Pilarcitos work. In fixing that price, I considered the fact that the whole 125 acres were not covered by any very heavy growth, and that there were spots that were quite open. There is not any heavy forestration in the valley. The sidehills are heavy forestration, but in the valley it is more or less brush and small trees.

Stripping: I assumed that would be done by means of 4-horse Fresno scrapers. The average haul is 350 feet, and I assumed an outfit whose total cost would be $198.50, and that that outfit would

move 880 yards. I added 25% to that for profit and incidentals, which gave me an average cost of 28 cents per cubic yard. I realize that part of that stripping was in the floor of the valley, and would 5032
be comparatively easily worked, and as you ascend with the construction of the dam, you would not do that stripping until you went up with the work. Experience has shown—and I have seen it done—that you do not carry that off, you just spread it over your dam. As your dam goes up 6 inches you remove a very small amount of material; the man shovels it, and spreads it over the dam; the brush and roots are removed, and although not incorporated into the puddle, it is incorporated into the dam—the material on the sides, so that if you allow a figure of 28 cents right through for the top and bottom, you have gotten a price that is fair.

Embankment: I assumed that work would be done by steam shovel, and my item of 36 cents per cubic yard is made up as follows: Getting the equipment on and off the job, 1 cent; general expense, 1¼ cents; excavation, steam shovel, 6.3 cents; 1,000 foot haul, 10.89 cents; handling it back, 8.87 cents. Total 28.31 cents. Profit, liability and insurance, 25%, or 7.8 cents, a total rounded out of 36 cents a cubic yard. I know that those figures are correct, from the data that I have, and it is borne out by the steam shovel work on the central reservoir work in Oakland. It is way in excess of the cost of steam shovel work in Los Angeles, as done by Mr. Mulholland.

I have the total cost of the reservoir in Oakland, every item of any nature. I have a copy of every bill that was paid. As to Los 5033
Angeles, I have the cost of moving earth by steam shovel, the output of the steam shovel, and covering a period of time as given to me by Mr. Mulholland. Those figures are on the Franklin Canyon Dam. At various times I have noted the shovel output at the Fernando Dam.

Questioned by Mr. McCutchen.

Here is a record of a model 40 shovel, 1¼ yard dipper, Marion. Working against a height of bank of 6 feet, with a width of cut at 22, the distance traveled by team of 2,250 feet, is not the lead, that is the distance actually traveled. That would be about 1100 foot lead—haul. 11 teams, number of loads in 8 hours 384. That is 691 cubic yards placed in the dam.

Working against a bank 8 feet high, with a width of cut 25 5034
feet, distance traveled 2500 feet, 14 teams, number of loads in 8 hours 598, cubic yards in place of dam 1,076.

With a height of bank 10 feet, width of cut 25 feet, distance traveled 2,450 feet, 15 teams, number of loads in 8 hours 659, cubic yards in place of dam 1,186, as against 1,076, and 691 in the other two cases.

These figures are based on the actual running time of the shovel, including the time in moving the shovel, 6 feet the length of cut.

They do not include any incidental or unavoidable delays, which are of almost daily occurrence in steam shovel operations; for the latter I would deduct about 10% from the figures given. I estimate a load to contain about 2¼ yards of loose earth. I am reading a letter from Mr. H. L. Jacques, who was one of Mr. Mulholland's assistant engineers in charge of the job, and who transmitted this data to me.

Questioned by Mr. Metcalf.

5035 This record is the average, and is not the record of the entire work. This information was sent me on April 28th, 1914. I am fully conversant with all of the points about the Franklin Canyon Dam. I am a student in the realm of fact, and I think Mr. Mulholland has the greatest university for an engineering education that I know of. After I work out a deduction, and submit it to him, I am pretty sure that the thing can be done. I asked him only for the average. I consider that as the average for the time they were working. Mr. Jacques states they do not include, however, any

5036 accidental or unavoidable delays, which are of almost daily occurrence in steam shovel operation; for the latter I would deduct about 10% from the figures given. These figures are based on the actual running time of the shovel, including the time required in moving the shovel its length of cut of 6 feet. He says that is the actual record on that work.

Questioned by Mr. McCutchen.

The letter here is in the condition I received it, and I have made no interpolation myself upon it. The headings of the tabulation, and the figures, were written, I should judge, by the same party who made the tabulation and fixed the figures.

DIRECT EXAMINATION BY MR. SEARLS.

5037 On the Franklin Canyon Dam, on Monday, November 1, 1915, as a result of 2 weeks run from October 18 to October 30, omitting Sundays, there were turned out by the steam shovel—

Questioned by Mr. McCutchen.

These are notes made by me at the time from the inspector's record; these records were made by me personally from the inspector's record. It is possible that there was not a steam shovel working every day.

DIRECT EXAMINATION BY MR. SEARLS.

I took down all the figures the inspectors gave me, as I wanted to determine for myself what would be the output of a steam shovel. This is a 1¼ yard dipper.

On October 18	588	wagon loads
On October 19	517	" "
On October 20	566	" "
On October 21	581	" "

On October 22	498	wagon	loads
On October 23	521	"	"
On October 25	568	"	"
On October 26	572	"	"
On October 27	347	"	"
On October 28	526	"	"
On October 29	546	"	"
On October 30	588	"	"

Each load holding 2½ yards, which compacted down in the dam to 2 yards. 5038

Questioned by Mr. McCutchen.

One load, 2, 1¼ yard dipper, heaping full, that is 2½ yards, and heaping full would make it almost 3, so that during an 8 hour day, working with only one steam shovel, the average for those 12 days is 1,070 yards compacted in the dam per 8 hour day.

DIRECT EXAMINATION BY MR. SEARLS.

My steam shovel in 9 hours, with a 1½ yard bucket, will enable me to put in 900 yards per day. I use a quarter of a yard larger bucket, and am working one hour longer than Mr. Mulholland's machine, and get 100 yards less, which I consider a safe average. I am strengthened in that fact by the performance of the steam shovel that built the central reservoirs in Oakland in 1909 and 1910. That work was done under special difficulties. Part of the time it was raining, and the teams had considerable difficulty in moving around. Then, that steam shovel was not working against a bank with the idea of getting out material, but it was getting out material, and also trimming up the basin of the reservoir, so that its output was limited, and it had to be moved frequently; it could not work up against a very heavy bank. 5039 That was between August and February. I got this information from the records of the Peoples Water Co. myself. The shovel operated between August, 1909, and February, 1910. It worked 22 days in August, and was charged for 139 days between August and February. It moved 142,150 yards during that time, and that will average over 1,000 yards. The days worked were: 26 days in September, 25 in October, 14 in November, 13 in December, 18 in January, and 21 in February, total 139 days. The company paid a rental of $50 a day for the actual time the shovel was in use, but they paid the wages of the shovel crew during the rainy days as well as other time. In other words, the shovel crew was paid for the time they were on the job, whether they worked or not. 5040

Questioned by Mr. Herrmann.

It was a large shovel, with a 1½ yard bucket, or something like that.

The 142,150 yards compacted to 130,150 yards measurement in place, so that in place that is an average of 936 yards for a 9½ hour day. With all those limitations, working on a 9 hour day, I
5041 make it come up to 887 yards, which is a confirmation of my 900 yards assumption in the dam. The 900 yards will take care of your lay-offs on the Pilarcitos Dam.

Questioned by Mr. McCutchen.

For the time that the shovel worked on the central reservoir job, including the 3 or 4 days that the shovel was being moved across the reservoir, there were the moves into new positions where they were trimming up new slopes, which would not take place at Pilarcitos. I included those, and my figure was for the actual running time.

5042

Questioned by Mr. Searls.

In figuring my shovel costs at Pilarcitos, I am figuring that you will have Sundays off, and if you had a lay-off during the day, or a loss of time, you would be paying your crew, and your depreciation would be running on. For that I have deducted the output 10%, which is intended to cover all that lost time.

Pilarcitos, for a 9 hour day, 1½ cubic yard dipper, loading a 2½ cubic yard wagon, working against a bank 10 feet or over, you can load 1,080 yards a day. These are figures I have made which lead me to take 900 yards.

5043 On the Pilarcitos job I did not charge shovel rental, as I assumed that the contractor owned the shovel. I take a model 40 Marion, 1½ yard dipper. Shovel costs f.o.b. San Francisco, $8,000, and its life is 5 years of 300 days each; the annual charge for depreciation on the shovel is $1,600. 6% on $8,000 is $480; repairs $1,200; total cost per annum, $3,280. Divide that by 300 working days, which gives you $10.93 per day as a fixed charge. The running charges are $38 a day, made up as follows: One engineer $6.50; crane man $5; fireman $3.50; five pit men at $2.50; oil 6 barrels at $1. Fuel haul $2.50; water estimated at $1; lubricants estimated at $1. Total $38. There are no teams or wagons in there. This is merely the cost of loading. When the shovel is working, you allow for one slip
5044 scraper, and 2 mules and 2 men to keep the shovel droppings out of the way of the teams, $7.21. Your daily operating costs are $56.14. On a basis of 900 yards per day, this will cost you 6.3 cents per yard for loading with a steam shovel.

Questioned by Mr. McCutchen.

This is on a basis of allowing you to run 300 days a year, and I allow for a possibility of interruption for 13 days in a year, and have assumed that for every other day the contractor would have to deliver that many yards.

Out of a period of 212 days the shovel on the Central Reservoir only succeeded in working 139 days, but there were other delays besides those caused by rain. I am not sure that they would have kept at work every day if they could have done so, because sometimes there they did not have wagons enough, and there was a great deal of moving around. That shovel was worked at a disadvantage, 5045
because it was used for the purpose of forming the bowl of the reservoir. I know that rain at Pilarcitos is much heavier than the rain at Oakland, but I have allowed only 13 days for stoppages due to wet weather and all other causes during the entire year. I have made liberal allowances to cover any oversight and omissions. Anyone conversant with the cost of running a steam shovel, will tell you that these figures are liberal.

DIRECT EXAMINATION BY MR. SEARLS.

We had 6.3 per yard for handling the material with the shovel. 5046
Getting the equipment on and off the job is 1 cent.

Mr. Herrmann: My figure was about ¾ of a cent, based on a merry-go-round. If you take a standard shovel in there, such as you are talking about, you will have to build a new road, and it would cost you 3 or 4 times as much as the shovel costs to get it in there.

Mr. Dockweiler: You could take a steam shovel over the roads that are in there now. I have estimated it, and made an allowance 5047
of $8,000 for getting those shovels on and off the job for both the San Andres and Pilarcitos. There are 800,000 yards, and that makes 1 cent a yard. The general expense I have of 1¼ cents. Besides the crew on the steam shovels and wagons, there will be the following general force: 2 foremen, one in each pit, $4, that is $8; a water boy at $2; time-keeper at $4; bookkeeper at $4; 1 watchman who looks after both shovels $4. The total general force is $22, and as there are 2 steam shovels, you divide the $22 by $1,800, and that gives you 1¼ cents per cubic yard. The excavation with the steam shovel is 6.3 cents per yard. The average haul is 1,000 feet. That is 10.89 cents per yard for hauling, and 8.87 for the handling on the dam. That includes sprinkling and rolling. That makes up my 36 cents. I gave my profits and liability insurance, etc., at 25% of that. I figured 9 hours a day for all unskilled labor on this work, 5048
at $2.50 a day.

Questioned by Mr. McCutchen.

The skilled labor I figured at 8 hours a day. On the trenching I assumed it would be the standard trench, as shown by the Spring Valley diagrams. I had a copy of the contract and drawings for the construction of the original dam, and I used the sizes set forth therein. I think the trench is about 12 feet wide, and of varying 5049
depths.

The 6400 cubic yards of trenching excavation—it is practically the clay in the valley floor—is approximately divided into 3,710 cubic yards below the level of the floor of the valley, and the remainder above said floor, and on both hillsides. The excavation will be handled as follows: Out of 3,710 cubic yards below the valley, 1200 cubic yards will be removed by wheel scrapers, leaving to handle 2,510 cubic yards by guy-derricks. The wheel scrapers will remove to a depth of 9 feet. Of the 2,510 cubic yards to be handled by derricks, all but 3 feet of this yardage is 6 cubic yards per man per day material; the lowest 3 feet is 2 cubic yards per day per man material. In other words, there are 2,110 cubic yards of 6 cubic yards per day per man material, and 400 cubic yards of 2 cubic yards per man per day material. The material on the sidehills, 2,690 cubic yards, is estimated at 4 cubic yards per man per day material. In taking out the first 9 feet with wheel scrapers, you use a 4-horse plow team that will cost $10.32; you use 7 wheel scrapers, and 2 snatch teams, and their drivers, 2 loaders, a straw boss and a water boy. You use half the time of a general foreman. That total outfit will cost you $71.54 per day; that will handle 180 yards,
5050 and is at the rate of 40 cents per cubic yard for that portion of the trench. Removing the 2,110 cubic yards in the puddle trench, below the valley floor, the surface point, and 3 feet above the bottom of the trench, the outfit I used for this is two 4-mule wagons and drivers to haul material to the lower side of the dam. I used 27 men, 1 carpenter at $5, 4 men at $3, 8 men at $2.50, 1 engineer on the hoist who runs the pump, 1 man who fires up, a dumper for the buckets, a general foreman, a sub-foreman, and a water boy. I used 4 barrels of oil for 17 hours a day, costing $8. The equipment costs $4,450. Charge off to this job at the rate of 20 cents a cubic yard. I am handling 160 a day, so that the charge for the equipment is $32. My estimate for getting out the 160 cubic yards is $183.24, or $1.15 for that part of the trench lying between the elevations indicated.

Excavating the bottom 3 feet of the trench below the valley floor, you remove 400 cubic yards. This material is 2 cubic yards per man for a 9 hour day. You require for this one 4-mule wagon outfit; 40 men, 9 men dumping, 1 engineer, 1 man who fires the engine, 1 dumper, a general foreman, a sub-foreman, a water boy, fuel $8, equipment 80 at 20 cents, $16. The total cost of that outfit is $182. Dividing this price by 80 cubic yards, it gives you $2.27 for the 400 cubic yards in the bottom of the trench. Then you have 2,690 cubic yards on the hillside, and I estimate that will cost you $1.17 per cubic yard. No pumping is required for this work. I figure an outfit that will cost you $186.74 a day, and will handle 160 cubic yards, or $1.17.

Timbering: The puddle trench is about 700 feet long, 12 feet wide. Practically all of the timbering was done on the part crossing the floor of the valley. No timbering was required, save for a stull or two in the upper part. This is my estimate, based upon reports on the contract, on Emery's testimony, and the report of Calvin Brown, the superintendent of the company. The Calvin Brown map attached to Emery's contract shows the extent of the trench excavated to be 240 lineal feet, and the shallow stripping into both sides. When he began his contract, he got paid for only 7,000 feet of lumber extra, and he states that he dug down the steps, and had to pump water. I am now reading from Mr. Emery's testimony in the Spring Valley case, page 33: "The same was commenced when I took the contract"—these are notes that I have made in arriving at my deduction. I am trying to get at the condition of that trench, and the amount of timber that was used in it, to give you a fair idea of the difficulties encountered. 5051

Questioned by Master.

I am producing it as the Spring Valley actually built it, of the same size as to length, width and depth. My impression is that I am using more lumber than was actually used to hold the trench up; I am using 270 feet of lumber in that trench. 5052

DIRECT EXAMINATION BY MR. SEARLS.

Continuing the reading from Mr. Emery's testimony, upon which the witness was interrupted: "The dam was commenced when I took "the contract. The foundation was dug out and prepared for the "clay to be put in. The puddle pit was dug down some 20 feet "below the surface, and it was blocked up so it would not cave."

Questioned by Master.

My authority for the 2 yard material, and the 3 yard material, was an inspection of what can be seen below the dam, and which shows that there is a valley fill. The contract called for them to dig down to the hard rock. We know that that material is overlain with a portion of soft rock; when you go down, first is the valley fill of earth; then comes the softer earth, and then the hard rock. In the very center of the valley I would not expect much soft rock to be found, because that would have been eroded off; but just apart from the stream channel itself you would have those three conditions. From an inspection of the country, they would not have to go down into the rock very far. I have seen a photograph of the Pilarcitos Dam, which shows the area adjoining and below the dam. An inspection of that photograph shows that the stream had cut quite a deep channel in the earth bank. I am justified in the assumption that a good deal of this material was earth; practically very little of it was soft rock, and an extremely small amount was hard rock, because they would stop when they would get to hard rock. 5053

Below the valley floor I have 1200 cubic yards at 40 cents; 2,110 cubic yards at $1.15; I have 400 cubic yards at $2.27. Above the valley floor I have 2,690 cubic yards at $1.17. This totals for the 6400 yards $6,961.80, or $1.09 per cubic yard. Add 25% for profit and so forth, and it gives you 27 cents per cubic yard. Add for lumber 31 cents per cubic yard, and it gives a total of $1.67 per cubic yard, the figure which I have used as the unit price.

The clay pits for the puddle core in trench: Within the reservoir a large pit of blue clay is located in the floor of the valley, 600 feet above the center of the dam, from which pit 50% of all the puddle clay was obtained. That information was given us by Mr. Ebright, who has resided at the reservoir for about 50 years, and he worked upon the construction of the dam.

Questioned by Mr. McCutchen.

He gave that information to me, to Mr. Grove Lawrence, the assistant superintendent of the water division of the Spring Valley
5054 Water Co., and to Mr. P. F. Jones of the Spring Valley Water Co., and to my assistant, Mr. Cragen.

The remaining 50% of the puddle was obtained as follows: In the easterly arm of the Pilarcitos Reservoir, at the mouth of the first ravine, crossed by the wagon road, leading northerly from the dam, is a pit of yellow clay, from which 15% of the total puddle clay was obtained. The wagon haul from this pit to the center of the dam is 1600 feet. A draw or depression located on the westerly side of the Pilarcitos arm of the reservoir is the site of a yellow clay pit from which was obtained 20% of the clay used in the dam. This pit covers about 1 acre of sidehill above the water level of the reservoir, and is a flat ravine extending about 300 feet along the slope. The distance which a wagon would have to travel from this pit to the center of the dam is estimated about 1500 feet. South of it and below the dam, on the west side of Pilarcitos Creek, at the base of the hill slope, is a yellow clay pit which furnished 15% of the clay. It is 1700 feet from this pit by wagon haul to the center of the dam.

The main embankment: The material which forms the main embankment was obtained at 3 points; 40% of it came from the sidehill below and east of the dam. This pit is about 400 feet long, lengthwise with the valley, and extends about 200 feet on the hill slope, covering an area of, say, 2 acres. From an inspection it appears that after the brush and trees had been grubbed out, the material was put into the dam, and no stripping was required; by wagon road it is 800 feet from the center of this borrow pit to the
5055 center of the dam. A second borrow pit, located in the floor of the valley, southerly of the dam, covers an area of about 1½ acres, with an average depth of, say, 10 feet; no stripping required; simply the removal of brush and trees. This pit furnished 10% of the material, and the average haul from it to the center of the dam is 700 feet.

The third pit is located in the ravine southwesterly of the dam. The average haul for a wagon would be 1200 feet from this pit to the center of the dam. This pit is on the south of, and runs up the ravine from the point where the flume and trestle cross the same. Clearing of brush and trees would be all that would be required. This pit is at the slope of a steep sidehill, and 50% of all the embankment material came from it.

SEVENTY-FIRST HEARING. DECEMBER 2, 1915.

Witnesses: J. H. Dockweiler for Defendants.
Allen Hazen for Plaintiff.
F. C. Herrmann for Plaintiff.

DIRECT EXAMINATION BY MR. SEARLS.

The puddle was obtained from three pits, and the haul was different from each pit. There were 6,860 cubic yards, which were brought in with a haul of 1,500 feet, at a unit cost of 75 cents; 5,145 cubic yards with a haul of 1,600 feet were 58 cents; the 5,146 cubic yards with a haul of 1,700 feet was 60 cents, and the average was 56.9 cents, and I allowed 72 cents as the cost of all puddle contained in the Pilarcitos Dam. The increase is for profits and liability. I added 25%, and those figures are made up by an analysis of the cost of excavating, hauling, placing, and ramming that material. 5056 5057

Questioned by Master.

For concrete in the puddle trench my figure is $8.50. I do not recall what my range of prices is for concrete. 5058

DIRECT EXAMINATION BY MR. SEARLS.

I estimated the cost of quarrying the rip-rap at 50 cents a cubic yard. There are quarries in the vicinity; one below the dam up the side ravine, and another looking up the reservoir from the dam on the left hand side at the base of a rock ledge. I figured that would be quarried there and brought and spread on the dam. The cost of quarrying per cubic yard would be 50 cents. The material will be brought in and spread for $1.01 per cubic yard, which makes $1.62 a cubic yard. A cubic yard of rock will give you more than 27 cubic feet of rip-rap, but I estimate that a cubic yard will give you a cubic yard of rip-rap, or a square yard three feet deep; this will give you 27 square feet 1 foot thick. 5059

Questioned by Mr. McCutchen.

I have an item of 50 cents a cubic yard for quarrying material, and $1.01 for hauling and spreading it, which would be $1.51, and then I rounded it off 6 cents to $1.62.

Questioned by Mr. Searls.

I did not make any allowance for benching old dams for additions, because that benching would not be performed in the reproduction of that dam as of the years in question.

5061 Mr. Hazen: I have excavating in earth trench 50 cents a cubic yard, which includes whatever backfill there was. I should not attempt to reconcile that with my 70 cent figure, as I do not think that I could possibly make an estimate of this kind and have it consistent on every point. However, in this case I think this was very easy digging, being a shallow trench along the floor of the valley, and the actual cost was very much less than ordinary pipe trench. A small job does not in this case cost more than a large one in proportion. I think the trench work done in connection with the main dam would be done just at the same price; it really is part of the big job.

5062 Mr. Dockweiler: Here is some data on the puddling, on the Dry Canyon Dam. This dam is comparatively a short ways out from Los Angeles, and the puddle cost 73 cents a cubic yard, but the depth of the excavation was from 80 to 90 feet. Taking the core wall of the Lower Haiwee Dam, the puddle fill cost 29 cents a cubic yard. That included just the cost of the material and the placing of it. In that case the puddle core trench was extended in places to 110 feet in depth.

Questioned by Mr. McCutchen.

The Haiwee cost was 29 cents per cubic yard, but I am not positive now whether that puddle was sluiced in hydraulically or not.

Mr. Herrmann: I am quite sure it was sluiced in hydraulically.

5063 It was sluiced in from the embankment simply forming the central part of the dam, the same as the rest of the core; it was not selected material. I saw the two different stages when the dam was being made, but the core wall had been put in by that time. I am certain that this Dry Canyon Dam was excavated, faced, and rammed, as Mr. Mulholland explained to me that it was expensive work.

DIRECT EXAMINATION BY MR. SEARLS.

I cannot tell you generally the source of my information as to all those small auxiliary items. I would have to refer to each item

5064 to see where I got my information.

Referring to page 5 of the schedule, item No. 27, 22 inch wrought iron riveted pipe syphon, 720 feet long: There is an error in my figure of $971.50 on that job. The 710 feet at $3.50 should be carried out as $2,485 instead of $248.50, so that my total would be $3,208. Mr. Hazen's figure is $4,000, and my figure in round numbers $2,700, and Mr. Dillman's in round numbers $3,200 on that.

Mr. Hazen: My figure is part of the total that adds up a certain figure, and that is compared by the check estimate which you have.

The preceding item for experimental apparatus, I remember upon looking at it, that that had been rather recently built, and this $642 was the actual cost. When I refer to the check estimate, I do not mean this 5065
was part of the dam structure that I compared with my New England Dam on the riveted pipe schedule—that is one of the items that make the total of four million, which gives the same total as my check estimate. The 22 inch pipe was estimated at the price per foot which I have given in my testimony, with an addition of $200 or $300, I think, which appears in one of my exhibits for the extra cost of delivery of the pipe in this very difficult location. In other words, I took 720 feet and multiplied it by my price per foot, and that includes excavation, backfill, valves, gates, and blow-offs. It also includes, in the case of syphons, some mouth pieces, which are added to the length of the pipe before making the multiplication; they are about 10 feet long, and really an extension.

Questioned by Mr. Searls.

Mr. Dockweiler: Referring to page 14; I have used the same price per acre for clearing, namely, $40. My excavation is 4 cents higher, being 32 cents instead of 28 cents, and the reason for that addition is that the average haul here is 450 feet. My haul at Pilarcitos is 350 feet average, but the Pilarcitos Dam is narrower than the base of the San Andres Dam, hence my haul is greater in the San Andres Dam than in the Pilarcitos. This material was hauled to 5067
allow it to be placed at the outside slope of the dam. I used an equipment of 30 scrapers, and estimated that each scraper would handle 36 yards a day, and the equipment cost is $275; that is the outfit of Fresnos, and the plows and men on the dumps, water boy, general foreman, and sub-foreman. Dividing $275 by 1080 gives me $25.47, to which I added 25%, and I rounded it out and called it 32 cents for stripping.

Mr. Hazen: I do not remember the reason for my difference of 40 cents for San Andres and 50 cents for Pilarcitos. I studied this out on the ground with the things laid before me, and I made no permanent record as to my reason for the difference.

Mr. Dockweiler: Having a longer haul, you need more of an outfit to move the material than you do on a shorter haul, but the difference of 4 cents is not exactly due to the longer haul. I have nothing here in my notes to show why I used this outfit at the Pilarcitos Dam, and the outfit which I estimated for the San Andres. 5068
The fact that you get less efficiency per scraper is one element, and then in each case I used 3 four-horse plows, and got a greater output at San Andres than I did at Pilarcitos, because it is a little more difficult at Pilarcitos. The valley is narrower, and there is not so much bottom, while in the San Andres the valley is wider, and the sides are not so steep.

Mr. Hazen: I was thinking Mr. Dockweiler had given an excellent explanation of why there was a 10 cent differential, and I see that the depth of this stripping at San Andres must have been considerably greater than at Pilarcitos, because the yardage was much greater in proportion to the area covered by the dam, and that would tend somewhat to increase the cost.

Mr. Dockweiler: From the records of the company, the San Andres trench was a very wide one. Profile No. 99, cross-section of
5069 the San Andres Dam, shows the deepest part of the trench to be 38 feet, and 17 feet the shallowest. The trench across the main San Andres Valley is 20 feet wide, while that across a small depression at the east portion of the dam is about 12 feet wide. The part of the dam across the main valley is 700 feet long, and the trench varies from 10 to 36 feet deep, while a part of the dam across the small depression is 200 feet long, and varies from 4 to 20 feet in depth. With a wider trench, you would expect a smaller cost per yard, because your timbering on the sides is the same whether your walls are 2 feet apart or 20 feet apart. The only difference in extra timbering that would come in would be in the spreaders which keep the sides from coming in. The haul at San Andres Dam is 800 feet; that is, the total actual distance traveled by a team is 700 feet, which is less than the haul at Pilarcitos. I think that is the only difference that would account for my embankment cost being 2 cents a yard less at San Andres than at Pilarcitos, namely, 34 cents a yard, as against 36 cents.

Of my puddle, I have 34,528 cubic yards at 80 cents, and 13,528 yards at 60 cents; averaging it, it comes to 74½ cents, which I have
5070 called 75. I have an average lead for my puddle at San Andres of 800 feet, a 1700 foot total team travel, and the haul for the puddle at Pilarcitos ranges from 1500 to 1700 feet. I cannot put my fingers on the reasons now why I had a greater unit price at San Andres than at Pilarcitos. I have this note though—as soon as the core is brought to the level of the top of the puddle trench, the puddling will go on simultaneously with the construction of the main embankment; in order to build the puddle core up at the same time as the embankment, it will be necessary to vary the outfit handling the puddle. At the base of the dam there is about 16 times as much embankment as puddle per vertical foot, and at the top of the dam only 5 times as much embankment as puddle. Therefore, with a fairly constant output of embankment from the shovel, the outfit placing puddle will need to vary its output from 100 cubic yards per day at the base of the dam, to about 400 cubic yards a day at the top of the dam in order to keep pace in a vertical direction with the embankment material. I have worked out the proportion that the puddle bears to the embankment as soon as the embankment begins to come above the surface. Of course, the puddle in the trench below the natural surface of the ground, or the base of the dam, is brought to the side of

the trench, and then thrown into the trench. I did not make it as a comparison of the difference in conditions as between San Andres and Pilarcitos. I took each job as it confronted me. 5071

Questioned by Master.

The figures in my cost analysis in one case work out with a certain figure at Pilarcitos, and with a different figure at San Andres, because I used different outfits. For instance, the cost of puddle above the trench, plowing, is 4.6 cents; to strip your pit is 2.9 cents.

Questioned by Mr. Searls.

The loading of the material costs 24.6 cents per yard, because it was hand work into wagons; the hauling costs you 19.8 cents a yard, so that the total cost of obtaining the material is 52 cents. Placing the puddle in the trench costs you 8.9 cents a yard, and water is 1 cent, which gives a total of 62 cents, and I allowed 25% profit, which gives me 77 cents and a fraction, which I rounded off to 80 cents. That is for 34,528 cubic yards of puddle. For the other puddle pits I get a different figure, and it comes out 75 cents. 5072

Mr. Hazen: My trenching figure on the dam that is east of the Serpentine Knoll, page 14, structure No. 2, is less, because it is easier work, not so deep, nor so wet. The embankment and puddle I have at the same price as Mr. Dockweiler, but there is $1 difference in our trenching.

Mr. Searls: Referring to the Upper Crystal Springs Dam; Mr. Hazen's total on that structure is $207,100, Mr. Dockweiler's is $144,-252, and Mr. Dillman's $136,071. 5073

Mr. Dockweiler: I worked it out both ways; I took the total reproduction value of the structures Nos. 1, 2, 3 and 4 in connection with the dam as $184,283. Then I took it again, considering this structure as out of use at present, and useful only for a county roadway and settling basin, and I allowed only for the yardage and rip-rap, giving that a reproduction value of $54,375.93 for earth embankment and for rip-rap.

Mr. Hazen: It is not quite right to consider only the matter of embankment there, because a simple embankment would not do. There has to be provision for carrying the ordinary flow and controlling it, and for carrying the flood flows across the embankment. If you were to simply build an embankment across there, it would be destroyed by the elements. It has to be a structure to carry flood flows, and that is quite an expensive structure in comparison with the embankment. That would not affect the cost of building the embankment itself, but that is included in my $135,000 that I allowed for that structure, which is part of the dam itself. My estimate for this whole dam complete was $261,300, and then with the overhead added, and the depreciation taken off, $135,000 is the final allowance for it. 5074

Mr. Dockweiler: I figured my depreciated figure at $54,375.93, and there should be concrete culverts taken in addition. The total 5075

of my four structures depreciated is $107,425. That is based on the reproduction, taking it unit by unit. The concrete culverts will have to be allowed to make allowance for the water of the upper basin to get into the lower one to provide against your roadway washing out. I carry it forward so that my total is $107,425.

Mr. Dillman: I figure cost of reproduction $197,670, which depreciated 80% makes the present value $39,500, which includes functional depreciation.

Mr. Hazen: I estimated what I thought it would cost to build an embankment to carry the road and culverts and gates that would be necessary, and I reached $135,000, and then made the depreciation. The formula by which I have valued puddle and so on counts for
5076 nothing. I just went through the motion to make it uniform with the rest of it. The item of 60 cents on the embankment is probably the item which I used on reproducing just the embankment, whereas, as a roadway fill, it could be built for less than that. 60 cents represents building it as a dam, and is comparable to the 65 cents in the other case. In this case there is also a better borrow pit than for the other two dams.

5077 Mr. Dockweiler: I have not a figure for embankment as a county road, but have built that as it would have to be built as a dam. I have left out the puddle core, the stripping, and the puddle trench excavation. This embankment is only 123,507 yards, as against the embankment of the present dam, 195,940, and I have used the same unit price for both of them—39 cents a cubic yard—but the yardage is different. I do not remember how we got the quantity of 123,000
5078 yards. I figured that the cubic yardage would be less if I simply had an embankment, than if I had the present dam; in other words, as a roadway 24 feet wide on top, with side slopes 2½ to 1. The present roadway is a narrow top put on a very broad base.

Mr. Hazen: I worked that out, and my impression is that the dam is rather narrow for a road at the present time, and that they have had to resort to something else than slope to get the width of road which is required at the present time, and that they need pretty nearly all the yardage that there is for a road. If Mr. Dockweiler's point is that the base is unnecessarily wide, then we will accept it.

Mr. Dockweiler: Referring to dam on San Mateo Creek, page 14 of my appraisal; I classified my puddle core there that 40% of the puddle would cost 58 cents, and 60% would cost 40 cents, and that rounded out comes to 48 cents a cubic yard. The puddle for this dam was obtained only 600 feet away. This was a settling dam, erected several years ago for the purpose of preventing any dirty water from getting into the Crystal Springs Dam. This dam is located in San
5079 Mateo Creek, and at the time it was built, a man by the name of Fifield owned some land in the watershed of the company, and he was maintaining a dairy. There were quite a number of willows growing

in the stream on his ground, and he cut the willows at times, which had a tendency to cause scouring out and carrying down of the debris, and this dam was put in to catch the muddy water, and impound the sill, so as to purify the water before it entered Crystal Springs Reservoir.

Mr. Lawrence: I think that is right in regards to facts. The San Mateo Creek, at Dam No. 2, empties into the Stone Dam aqueduct system; there is no connection where the dam is, but further down there is, at the inlet of the Stone Dam Aqueduct No. 2. The water is diverted at the Stone Intake Dam into the Stone Dam aqueduct system, and into San Andres. Counting the large Crystal Springs Dam, 5080
there are 3 dams on San Mateo Creek. The company today owns all the land above San Mateo Dam No. 1 to the head waters of San Mateo Creek, which was not the case at the time the dam was built.

Mr. Dockweiler: I arrived at all these items in the same way 5081
that I got my figures on San Andres and Crystal Springs; that is, by estimating the reproduction in detail.

Witness: ALLEN HAZEN for Plaintiff. Hazen

Mr. Hazen: Referring to the reproduction cost of the dam: The 5082
method of building by scrapers, that Mr. Herrmann suggested, I think, was also a modern method. I do not believe that was in use when this dam was built, and as far as building with the scraper is concerned, I should be disposed to accept Mr. Herrmann's analysis; it seemed to me sound, and I do not know of any reason why that would not be the best evidence I could get on that point. If you go back to building it by the methods that were used when this dam was built, I should say there was no doubt it would cost a great deal more to 5083
build than these figures.

CROSS EXAMINATION BY MR. SEARLS.

These earth dams were the first earth dams that I had figured the reproduction of in California. I estimate it would take two years to produce the Pilarcitos Dam, and the same time to produce the San Andres Dam. The Borden Brook Dam was all done in one year, and was approximately the same height as these dams, but not so long at the bottom. It was nearly as long on the top. The yardage of the Borden Brook Dam was about 146,000 yards, and that would be near a third of the yardage in the Pilarcitos, if you considered the yardage of puddle in the trench. At the rate we built the Borden Brook Dam, 5084
if it had been the same size as the Pilarcitos, it might have taken 2 or 3 years to build it. There was quite a little interruption by rain in building that dam, but I could not tell you our efficiency in working days as compared with the lapse of time. For a rough estimate, I

should imagine that there would be between 10 and 20 percent of the time when work was either stopped or interfered with because the material was too wet, and because it made the roads wet over which the hauling had to be done. I would expect much less interference on account of rains in constructing these dams, assuming that the work would be done mainly in the summer season. Through the summer the percentage of efficiency in working time here would be pretty nearly 100% as far as the weather was concerned. In the winter it would not differ very much from the Massachusetts conditions. I presume in the winter that the contractor would lay off his force, and
5085 stop work, and if that were the case, the increased expense due to the interruption by rain would be practically limited to the interest and depreciation on such of his equipment as he had to leave in there.

The material in the Borden Brook Dam was generally clay, but a clay that carried a good deal of sand, and some gravel with it. We did not have to blast, but it was advantageous to do so, because the steam shovel worked more readily and rapidly after some blasting had been done in advance. To get a good face for a steam shovel, I should think that blasting would be necessary at Pilarcitos. If one went around with scrapers and took material here and there, it could be got without blasting. I think if you went too far, you would find rock there that would make it difficult to handle with a steam shovel. I have not studied the history of the construction of the Pilarcitos Dam to have any judgment on that. I do not understand that they used
5086 steam shovels, so there is no record that perhaps could throw light on it. I did not pay much attention to the record which shows the kind of material they had to deal with. I looked at the dam, its surroundings, and the material that was exposed, and formed my judgment on that, and not on any old papers that were there. The history of the construction of the dam might have thrown some light on the question, but usually I do not think those things done so long ago are very helpful. If it had been done recently, and by methods similar to those that would be used now, then it is much more important for consideration.

The Borden Brook Dam was built with steam shovels, and the material hauled in two-wheeled carts, and rolled with a 10-ton roller. I think also four-wheeled carts were used on that. In reproducing the Pilarcitos Dam, I assumed the same general equipment would be used. I do not think I could give you an estimate of the amount of investment the contractor would have to make in equipment to handle the job. I have not handled the work that way. We have been used
5087 to doing work by contract. The contractor provides the equipment, and I have been more used to studying the contractor's prices than in trying to reproduce his cost account. It would also depend upon how rapidly the work was prosecuted. I do not think it would be possible to make any adequate calculation as to what the contractor's

loss would be, or what the increased expense would be due to the equipment which he would have to leave in the Pilarcitos Valley during the rainy season. It has seemed to me a reasonable assumption that the increase in the labor cost here, compared with the cost of work, not only at Borden Brook, but other work that I have had to do with in recent years, where the labor cost has run about 20 cents an hour, that the increased labor cost here would just about offset the difference in climate. The common labor basis on the Borden Brook Dam was about 20 cents an hour, and a 10-hour day ordinarily, which would be $2 for the day. That has to be taken in connection with the conditions, and I think sometimes they worked longer than that, but 5088
the payments were so much per hour. I think that $2 for 10 hours is about a representative figure on the Borden Brook work. The added cost is not represented entirely by the time that the work shuts down. After a rain they would start to work just as soon as they could, and the first work that is done after a rain costs a good deal more per cubic yard than the work done later on after it gets dried out, and the proportion of time that they are shut down would not be an adequate measure of the increase of the cost of the work because of the rain.

My figures are an average for all conditions, whether wet or dry. If we could take days when work was laid off, and compare them with my Eastern days, it would not be a fair basis as to what the difference would be out here. I do not think that takes into account all the 5089
differences. I assumed, in this whole estimate, that the ordinary normal rate of labor wages would be $2.50 for 8 hours, but I assumed that sometimes in the remote parts of the work that $2.50 would be paid, but the hours would be longer. The 8 hour day was merely an assumption on my part. If it should be brought to my attention from a reliable source that the work could be done on a $2.50 basis for a 10 hour day, it would tend somewhat to alter my course. In connection with that, I got through Mr. Hood a lot of representative payrolls from the Southern Pacific Railroad, and I think the rates of pay on the work that comes and goes are variable. I think they are more variable than they are in the East. You can take some of his payrolls at certain times where he paid lower rates, and then there are other times when he paid much higher rates, and I think for the purpose of this discussion that the general conditions ought to control, and not the conditions at time of depression, or conditions of a time 5090
of unusual activity when it was hard to get men. These payrolls of Mr. Hood's cover various classes of work, and related to work done in the neighborhood of San Francisco entirely. I think some of these payrolls related to work in connection with the Dumbarton cut-off, but I did not inquire what labor was represented by these payrolls. I simply got the going rates that were being paid at these times.

I have had a good deal of experience with labor unions in various 5091
parts of the country, and I should expect that if a large piece of work

were being carried out, and thousands of men were being employed on the peninsula, as would be the case if this work were being prosecuted, that the field of control of the labor unions would be expended to cover it; at least a determined effort would be made to bring that about by the unions. That is an important element in the situation, and something that has to be considered in reference to the probable cost of work of this kind. I could not say whether that was the experience on the Los Angeles Aqueduct, or on the heavy construction of the Southern Pacific Co., on the mountain division. I have not had that experience in California.

5092 Referring to a type written sheet of data presented in reference to the Upper Crystal Springs Dam, and included in the schedule of exhibits as "Plaintiff's Exhibit 98r": The lower culvert is necessary to enable the water to be drawn out in event of the water being low in the reservoir, and it is necessary to use the storage. That is not large enough to carry flows—although indispensable—so another one is necessary at a higher level. It certainly would not be safe without more capacity than the bottom culvert. If it were to be built now, I think very likely the bottom culvert might be large enough to perform both functions, and in that event it would have to be very much larger. As the bottom culvert is much longer than the upper one, I think it is a question if the structure that performed both services would not be as expensive as the structures as they are now. However, I did not go into that. I think there is much advantage in being able to

5093 draw the top water, or the bottom water, as can now be done, and I do not think it would be quite the equivalent if there were but one culvert.

I also looked into the question roughly that Mr. Dockweiler raised as to whether the embankment was wider than was necessary to carry the road. I find it could be narrowed up a little in reference to the present road, but if that were done, it would be necessary to rip-rap, and I did not include the rip-rap last year, because on the present rather liberal section it did not seem to be necessary to fully rip-rap it. If any cut was made in the estimated embankment, the addition of rip-rap would have to go with it. This estimate is not based on the whole volume of the dam as it now is, but all the stripping and trench work is excluded, and the volume is reduced by that amount. The cubic yardage that is in the puddle above the original surface is in-

5094 cluded, and all the work below the original surface is excluded, and this, put in at 40 cents per cubic yard as the ordinary fill, in comparison with 60 or 65 cents as a dam. In my judgment, that was the difference in the cost of doing the work with the same material. In one case it is simply dumped, and in the other it is sorted, spread, watered, rolled, and made into an impervious dam. I think this figure of 183,000 cubic yards is obtained by adding the earth embankment and the puddle, and deducting the puddle trench and the stripping.

If the lower Crystal Springs Dam were raised, this fill would have to be raised, and in that event the whole yardage in the present structure would be utilized.

The figure of 40 cents is my judgment of what it would cost to do the work. I have done earth work a great many places, such as Albany, Springfield, Yonkers, Peekskill, Washington, at a price that approximates that. At Springfield there was nearly $2,000,000 worth 5095
of work, and it included a great many items of earth work. Some of it was done for 30 cents a yard, while others ranged up to $8 a yard. The 30 cents a yard structures were what we ordinarily called general fill, where material is taken from a good borrow pit, and deposited in a convenient location, without any special attention being given to it. We used embankments for a great many purposes, backing up masonry walls, bridges and structures to cover over the top of reservoirs and filters. None of the embankments at Springfield were used to hold water, and when I stated that this embankment at Upper Crystal Springs would have to be assorted, sprinkled and rolled, that covered the difference between that and ordinary dam construction. It was 20 cents a yard for assorting, rolling and 5096
sprinkling in this case, because this dam had a better borrow pit, and I estimated it at 60 cents as a dam, and 40 cents as an embankment. The separation of the material involves a good deal of added expense, because the materials occur in the borrow pits in various ways, and they have to be sorted out and loaded more or less separately, and kept track of, and brought on in the right order, and it makes quite a little difference keeping them separate, and putting them where they want to, as compared with taking them when they come. It is not possible to work with a 5097
steam shovel in a deep face running through various layers, and take those layers out and put them in different teams, without some added attention, and considerably added expense. In reference to the work at Calaveras, I was not aware that they loaded from the same shovel one team with rock, and another with softer dirt. Of course, there is nothing impracticable about making the separation; it is simply one of the things that adds expense to the work where it is properly done.

The payrolls that Mr. Hood sent me copies of were some of them relating to the Bayside cut-off, and some to the Dumbarton cut-off. I did not see any of the payrolls beyond that; I asked for payrolls in this vicinity. The payrolls for the Bayside cut-off ran from 1906 5098
to 1910. My information as to wages the Southern Pacific paid on the Bayside cut-off were these payrolls.

Questioned by Master.

The year 1908 was the low point in that series of payrolls, and they were employing some particular men for $1.75 for that year. In 1907 they were paying $2.25 for the same labor. Other years they

paid more. Mr. Searls asked me about the lowest point in the schedules. There was a great deal of fluctuation. The S. P. employ their men 10 hours, but I adopted an 8 hour basis ordinarily.

CROSS EXAMINATION BY MR. SEARLS.

They have some old men who are employed the year round who get 25 cents less than the men who are taken on for temporary work, and men who are employed on concrete or masonry work, whom we ordinarily rate as day labor, get 25 cents above that. Those things have to be taken into account. I did not assume that any common
5099 labor was paid more than $2.50 at any time since 1907, nor did I assume that the average would be $2.50. I assumed that $2.50 for 8 hours would be the ordinary rate, but that $2.50 for more than 8 hours would be sometimes paid in the remote parts of the work. I have no knowledge of the cost of clearing land similar to the land at Pilarcitos and San Andres, in California. I should not know whether the cost for clearing land on the hillsides here would be exactly the same as in the eastern states, not having supervised any jobs of clearing out here. I made no separate assumptions for wages and hours in that work. I took our eastern costs, and made an application to California on general principles. Work of that kind in the East has averaged about $50 an acre. That has been quite a consistent figure on several pieces of work I have known of, and have good data on. In this case I estimated 20% more. Referring to the period which goes with the data I have just spoken of, the wages paid in the East for that work are 20 cents per hour. At the present time
5100 the wages are running higher. In 1913 the 20 cents an hour would have been about right for eastern conditions; in 1915 it is not right.

Up to a few years ago, the 9 hour day has been ordinarily used on work of this kind, or 10 hours, or even more in cases have frequently been used in out of the way work like Borden Brook, especially on rainy days when the men could not work a full day on one day, and they would work longer hours on the other days. For the last two or three years it has been coming very rapidly, and we are getting on an 8 hour basis, so that practically we will not figure on anything else on current estimates in the East now. In the East there is no particular kind of labor used. For clearing, the best work is done by the French Canadians; the Italians do some things very well, and then there are Austrians, and Greeks, and a great many American workmen. As to clearing the French Canadians
5101 have a special knack, and they have the preference on that class of work.

I did not figure any particular output for the steam shovel for embankment work. I simply took my average costs, and resolved them into local conditions.

Mr. Searls: I have some information here from Mr. O'Shaughnessy: He has let a contract for clearing 800 acres in the Hetch-Hetchy Valley for $30,000, and that is on a $3 a day labor basis, and makes about $35 an acre. It includes a lot of heavy growth timber, but does not include the whole floor of the valley.

Mr. O'Shaughnessy: It includes the portion where there is no 5102
growth, and where there is growth, and around the borders.

CROSS EXAMINATION BY MR. SEARLS.

I estimated $2.50 a cubic yard for the trench end of the dam. There was very little trenching on the Borden Brook Dam, as we had a very good foundation. At Borden Brook our dam rested on rock on one side, and on clay on the other. On another dam, which was part of the Springfield System, and which is more comparable, perhaps, to this, the cost was something over $8. It was a trench about 20 feet wide, and 28 feet deep, and the maximum going down below the floor of the valley. It was very difficult because of the 5103
water, which accounted for the high cost. I did not use that, except as one of the elements of my experience. I have not the figures of other trenches in mind, but I have been in these trenches on quite a number of important dams, and I know that the work was very expensive. I have no direct information as to the cost of trenching on any dams in California, outside of these. I do not remember the original contract price for the construction of the Pilarcitos Dam.

Mr. Dockweiler: Mr. Emery testified that he built the Pilar- 5104
citos Dam, and carried it through. He did not testify that he made any loss. His contract called for the stone pitching, which we call rip-rap here, the building of the puddle, and the embankment work, and also the excavation of the trench into the sidehill. The Emery contract was accompanied by a map which showed the trace of the dam and a cross-section. At that time it indicated the depth of the trench, and Mr. Emery had to do a little of that work in addition, and maintain a pump. Assume that he broke even and may not have made a profit; he did that with hand labor, using no machinery whatever, and hauling the material in by cars. There is no waste material lying around, as far as I can see, and the conclusion is that everything that went out of those pits was incorporated into the dam. Also there was a second contract let to Mr. Hancock, at 45 cents, for additional work in the raising of the dam, and the addition of the width on the lower side.

Mr. Greene: The minutes of the company show that the original contractor asked to be relieved from the contract, and for help from the company, and he was relieved, and he got the help.

Mr. Hazen: Assuming that the Crystal Springs Reservoir were 5105
to be taken as a whole without this dam running through it as it does today; it might be considered whether a bridge could be sub-

stituted for the embankment. If that were done, from the standpoint of quality of water, the water drawn from the reservoir would be somewhat more turbid than it now is, and there would be some disadvantage in the substitution. I have not gone into the question as to whether a bridge could be built for less money than the embankment, but I should imagine that with the length and depth you have it would not be very much. I am assuming a good, substantial, steel bridge, and it would be rather expensive, because it is
5106 a long span there for a single span. You would use one pier or perhaps two, and that would cost a great deal of money. A concrete arch bridge would make a much better structure, and would be more nearly the equivalent of the embankment, and I think would undoubtedly cost more than the embankment. That is an offhand opinion. If you were to carry the roadway a little further down, around the upper end of the lake, by a short bridge or embankment, that would add at least several miles to the road to Half Moon Bay, and my experience in dealing with local authorities does not lead me to think that that would be very likely to be successful.

Questioned by Master.

There is quite a difference in the turbidity of the water at that end and at the other end, especially in winter. The fact that the more turbid water is kept by itself, and allowed to settle somewhat, and only the top drawn off, means that a substantially clearer water can be drawn from the reservoir than could be drawn if a bridge were built, and free circulation was permitted underneath.

CROSS EXAMINATION BY MR. SEARLS.

The Wachusett Reservoir has an embankment built across the middle of it to separate the water, and that is a larger reservoir in area than Crystal Springs. I am speaking about a roadway, but with reference to an embankment to preserve the clarity of the
5107 water, I will mention the Croton Reservoir, supplying the City of New York, which is divided in that way by an auxiliary dam, built for the sole purpose of improving the quality of the water. That reservoir is larger than the Crystal Springs Reservoir. It is longer, and I am not sure whether it is wider or not. I should think the average width in a general way might not be so very different. That dam was to protect the quality of the water, and the question of organisms came in as well as turbidity, and that question arises in the case of the Crystal Springs with respect to the water in the southern end of the lake.

I did not see all of the dam along the aqueduct at Los Angeles,
5108 but I saw the San Fernando Dam in the course of construction, and the dam at Franklin Canyon, and one or two reservoir dams in the city that have been completed many years. I did not have the data covering the cost of construction on the Franklin Dam before me

at the time I made this appraisal, because that dam is not finished yet, and I would say it is premature to figure what it would cost before they get through. The upper dam in Franklin Canyon is a very small dam. It is probably a tenth as large as Pilarcitos, and may be 25 feet high. I saw a foundation for that dam after I made this estimate. I do not think there is any comparison between 5109
the work on the Pilarcitos and San Andres, and the Calaveras dam in relation to the speed with which the work would be conducted. It would be done by a different method, and is a different kind of material entirely. They are not building an embankment at Calaveras with a steam shovel that in itself would be a dam. They are blasting rock, and handling the rock with steam shovels, and dumping that in one part of the dam, and it is all right in connection with the hydraulic fill, but that in itself would not constitute a dam comparable to Pilarcitos or San Andres Dams. At the Calaveras Dam you have two embankments with hydraulic material sluiced in between them, and that serves in place of a puddle core, but I would not consider it, so far as the embankment goes, comparable, even if it were not rolled and sprinkled to the same extent. I should not consider that good dam construction for a dam of the Pilarcitos type, with the puddle core put in in the old way in the middle, a comparatively narrow core. At Calaveras the hydraulic fill material runs out through the loose rock, and deposits a good deal of clay in the interstices of it, and introduces an entirely different condition from 5110
what you would get if you would build a fill of that kind, and carry it up in connection with a dry puddle core in the middle. I do not think that is a comparable case. When I estimated the Pilarcitos, I did not use the Calaveras in any way as comparable work. The steam shovel work had not begun at Calaveras at that time, and that work is costing something over 50 cents a cubic yard at the present time, but they are not through with it yet. In my judgment, when they get through with Calaveras, and pay all the bills, that part of the work which is done in this way will cost considerably more than 53 cents per cubic yard.

Questioned by Mr. Greene.

That period of 50 cents represents recent work, and covers a period of say, in a general way since March or April of this year.

RE-DIRECT EXAMINATION BY MR. GREENE.

I made an additional allowance for the clearing out here over what it would cost in the East, because I think it costs more. I was 5111
thinking of the New England thicket growth to some extent. If I had had the costs of the Pilarcitos and San Andres Dams, which were constructed in the 60's, I should not have paid any attention to them in estimating the value of those dams in 1913. I did inquire about the cost of all the recent work, and there was not any fixed

limit that I stopped at. It depended on the construction and the conditions, but I did not ask the cost of anything that went back as far as that.

Herrmann Witnesses: F. C. HERRMANN for Plaintiff.

CROSS EXAMINATION BY MR. SEARLS.

5112 These are the items that were given me by Mr. Clemens as making up the 33.85 percent of indirect cost—I used 33.8 percent.

Preliminary engineering	1.74	percent
Divisional administration, which is a superintendent on the job; that is the superintendent and his clerical force with him on the job—not the head office	6.52	"
The water supply	6.89	"
Roads and trails	0.97	"
Buildings	3.21	"
Telephones	0.89	"
Equipment	11.34	"
Miscellaneous	2.29	"
Making a total of	33.85	percent

Mr. Clemens gave me the figures in this way: He gave me items of direct charges, and then said that to the various dams on the Los Angeles aqueduct there should be added these items for auxiliary cost, and to that should be added the overhead of the inside office, administration, etc., as a separate item. These auxiliary costs were the costs of work that could not be charged directly to any one class of work, but were pro-rated over the entire structure. He has a figure here "Los Angeles, office administration 3.56 percent."
5113 That is after all auxiliaries are added to direct charges. These auxiliary expenses are expenses that are really spent on the job itself, and are pro-rated because they cannot be charged directly to any one class of work. I have not tried to find what charges they made for overhead, because it was not in my province. Mr. Clemens made this note here, and I do not know what else should be added.

I did not give you roads and trails, but I gave you buildings as 3.21; roads and trails are 0.97. It is not my understanding that 3.56 would cover all the other engineering on the job. He has put an item down here "Los Angeles, office administration", but whether
5114 that carries with it the other engineering or not, I do not know. The 1.74 is only preliminary engineering, which I presume is location,

and work of that type before construction. I have a note here as follows: The divisional administration consists of superintendence, clerical force, warehouse expenses, including handling of freight and hauling, camp expense, etc. Water supply is the difference between net salvage and the installed value of the system, plus operating and maintenance. Equipment is the gross value less the net salvage value.

I want to correct one thing: I didn't mean to say in any way that these were comparable to the Pilarcitos Dam. An entirely different method was used to construct all of these Los Angeles aqueduct dams, and it is an entirely different type of dam; it is more in the way of knowing what general types of work cost. I would not say that I did not use any of those Los Angeles costs in making my appraisal. I had them in mind, as I have had other costs in mind. The embankment itself is 28 cents without the addition of these auxiliary expenses which should be added to it. I gave these 5115
Los Angeles costs very little weight for the construction of a dam of the type of the Pilarcitos and San Andres Dams, except in-so-far as portions of them, like the excavation of those trenches, would be comparable. The excavation for trenches included the auxiliary expense items. The question of water supply for the working force at Pilarcitos being simpler, that might or might not be the case. The water is very much more plentiful, but in this case the water supply was handled for the entire stretch of the work; it was not the case of building a water supply for the Haiwee Dam alone, but for the whole aqueduct, and so the Haiwee Dam got the benefit of what was done for the other work. I would expect to find water at Pilarcitos all the year round, but so far as absolute knowledge is concerned, I haven't it. I do not know whether the item of getting 5116
water at Pilarcitos to use on the work and for a camp would amount to practically 7% of the entire cost or not. I did not estimate at all what that would cost in making my appraisal. I know that where we had living water at Calaveras, the matter of a camp was quite a considerable item that had to be pro-rated over the cost of the work.

Questioned by Master.

For my puddle excavation at the South Haiwee Dam, I give $2.58 per cubic yard, plus 33.8 percent, making $3.44, which included the pumping.

CROSS EXAMINATION BY MR. SEARLS.

In appraising the Pilarcitos Dam, the figure that I arrived at was the bare bones figure, and was not intended to include engineering, or any overhead charges, nor any exploration work or preliminary work that is necessary with every dam. The divisional administration is the superintendent and his clerical force on the job, and I included that in my Pilarcitos cost, as that is a field cost. 5117

I did not include preliminary engineering at Pilarcitos as divisional administration.

Questioned by Mr. McCutchen.

It would be necessary to make borings before the dam construction began; it is not reflected, however, in the figures I have given.

CROSS EXAMINATION BY MR. SEARLS.

The roads and trails that are in the Pilarcitos country now would be but a very small fraction of what it would be necessary to build during the progress of the work. As your dirt comes up, you are building roadways and trails and passageways all the time that are covered as you proceed. They are necessary in hauling here and there, but they leave no sign behind them whatever. The item of 0.97 percent in the Haiwee estimate includes very little, I think, from the size of it, in the way of lateral road from the main high-
5118 way to the property. My idea is that the roads and trails on a job of that sort would be a much larger percentage. I do not know what that figure includes, but I do know that the roads and trails on the Calaveras work run to a very much higher percentage. To clear the right of way between Calaveras and the Rosedale Bridge, it cost $53 an acre in 1913, and I put my labor at $2.50 for 10 hours. The bare costs of clearing the Calaveras site are running about $30 an acre, but it is impossible to tell until the job is completed as to what must be added to that in the way of accounts that run in. They tried to do it by contract for awhile, but the contractor went broke, and left it on the company's hands.

Questioned by Master.

To measure my acreage in that case, I took what I thought was a very liberal area that was covered by trees and brush. It also includes the thick stuff in the gulches, and the bottom of the valley
5119 that is covered with sycamores. The 125 acres is not all of the reservoir site at Pilarcitos, and I have tried to take a comparable area in Calaveras. I have tried to eliminate the areas in which there are no brush or trees. I have included those where there was a scattering of trees, which is rather a large area in the bottom of the Calaveras Valley. It is very difficult to apply my figures from one place to another, but I think that the clearing of the right of way between Calaveras and the Rosedale Bridge was more comparable to the Pilarcitos than the other figure, but so long as I could get the other figure, I wanted to have it as an index, and simply to show what it was costing, and use it for what it was worth.

CROSS EXAMINATION BY MR. SEARLS.

In comparing the Calaveras Reservoir Site with the Pilarcitos, I tried to eliminate areas in which there was no growth at all. I assumed that 125 acres were covered with growth. I think it is

quite probable that at the time the Pilarcitos Dam was built there was some scattering growth that had to be cleared out of the reservoir site proper.

I am familiar with the country in the San Mateo Creek Canyon, 5120
and would expect to find the Pilarcitos Valley different from that. I would think that the Pilarcitos Valley would be more like the valley below the Pilarcitos Dam. The canyon below the dam is not very much narrower than above. The valley below the Pilarcitos Dam is not like the country that you see today in San Mateo Canyon.

The real purpose of the Pilarcitos Reservoir is regulating the 5121
water so that it can be stored in the San Andres Reservoir, and the Pilarcitos Reservoir as a storage reservoir is not nearly so valuable as for the regulation of water to be stored in the San Andres Reservoir, where there is ample storage capacity. The Pilarcitos Reservoir was built first, and at that time, for the amount of water that was necessary, was built to store water. The consumption was very small at that time compared with the storage capacity.

I spoke about clearing the land on the right of way of the levees along the Colorado River for about 20 miles. That growth was a mixture of arrow weed, mesquite, grease-wood, willows, and some cotton woods. We used Mexican labor on that at $1.60 a day for a 10 hour day, and it cost $65 per acre. The right of way for levees along the Colorado River was grubbed as well as cleared, and if we had 5122
not grubbed it, I think it would have cost about half. The item of 22¼ cents a yard was the cost of stripping in the flat at Calaveras, and reducing it to an 8 hour day basis, I made it 28 cents a yard. We stripped with a jet on the hillside in Calaveras the same as we did with the Freeman dam site when we were carrying on explorations for Mr. John R. Freeman at the lower dam site. One of my estimates here for stripping at Pilarcitos or San Andres is by using that method. The stripping of the Freeman dam site cost about 22 cents a yard, based on a $2.50 day of 10 hours, and the power at .9 of a cent per kilowatt hour. I think you would expect to pay more than that for power on the Peninsular Reservoir, which would probably increase the total cost about 2 or 3 or 4 percent; something like 5123
that. The power itself would probably cost 1 cent per kilowatt hour instead of .9 of a cent per kilowatt hour. Of course that 22 cents is just the field cost on the job, and has nothing to do with the power line you would have to build, the equipment you would have to put in, or the cost of installation of that equipment. The 22 cents that I speak of was the operating cost of the job. I do not remember now what the figure was for stripping cost at Calaveras. The actual field cost of the work was 22 cents. The power plant cost about $5,000 without the power line, which was about $9,000 more. I figure that the stripping by the hydraulic method at Pilarcitos for 5124
the side slopes would cost at least 46 cents a yard after having taken

into account the power plant, and distributing it, and charging it out against the two jobs. The yardage that is in the bottom cannot be stripped by the hydraulic process, because you have no way of getting rid of your material. Of course, you can only get rid of a part of the material on your sides.

In making this estimate, I segregated my power charge from the operating charge. I took the plant and distributed it the way I said first, which amounts to 25 cents a cubic yard for the plant charge. Then I took the 22 cents at Calaveras for the stripping of the Freeman dam site, of which 40% was labor, and changed the 40% of the 22 cents over to an 8 hour basis for the same price, $2.50 a day, so that the charge then becomes 24 cents for that operating, which must be added to the 25 cents of the plant charge, giving 49 cents, and leaving the sides of it in a very ragged shape. Then I added 2 cents a yard for fixing those ragged pieces and getting them in shape, and then figured you could not dispose of a portion of those sides, because of the fact that you did not have grades to carry it off to the dump, and that that would have to be handled separately.
5125 6,000 of that 18,000 would have to be handled in a very difficult way. That would leave fragments of rock and things of that kind that were left behind and deposited at the foot of the slope, and that would be all hand work, which would probably cost you 60 cents a yard to get out. You figure from the 46 cents a yard for stripping by averaging all of those prices. These are checking estimates, because I feel that nobody can get these estimates with any degree of accuracy. The bottom of it is taken out with scrapers, and is cheaper. There are 9,000 yards in the bottom that are stripped with scrapers at 28 cents. If I were to assume a 10 hour basis, instead of an 8 hour basis, it would reduce the labor cost, but this is not all
5126 labor. It would reduce the hydraulic stripping part, which is a part of the sidehills, 2 cents. The 28 cents in the bottom would also be reduced, and it would make the price less than 47 cents. It would make it possibly 4 or 5 cents less, but I do not believe it would be possible to run the job out there on all of this work on a 10 hour day.

The Drum forebay is situated, I think, about 10 or 12 miles below the Spaulding Dam. It is in the Bear River Watershed, but not in the river itself. It is where the waters from Spaulding Dam are carried to a place where they drop into the power house, and this Drum forebay is on the top of the ridge at the beginning of a pipe line that goes down the hill. The embankment there, I think,
5127 is about 35 feet high, and its aggregate length, I should say, 3,000 feet. It is constructed of material selected mostly from the interior of the forebay. They had a bank from which they were working a steam shovel, which was, according to my recollection, about 6 to 10 feet high, but they found the use of a steam shovel very unsatisfactory, and finished the dam with scrapers, because they could not seg-

regate the material with the steam shovel. They encountered some loose fragments of rock, but no more than you would find anywhere else. The percentage of rock was comparatively small, and the steam shovel did not have to dig any. You could dig out loose rock with a steam shovel very easily. I do not know what the depth to bed-rock was. I was on the job several times, but I did not see any bed-rock outcroppings at the reservoir itself. I do not think they had to blast. The difficulty they had with the steam shovel was that the material was in layers, some of which were very moist, and when they worked against the bank, the dipper would rake up along the bank and get all kinds of material, and a mixture of these materials was dumped into the wagons of whatever moisture they happened to have. Very 5128
often it was of such moisture that it was difficult to roll, and they would have to stop the work, or alter their pit, in order to accommodate that. Whereas, later, when they were using plows and scrapers if the borrow pit showed undue moisture, they plowed it and left it to dry for a few hours or days until it was of the proper consistency so they could put it in the dam and roll it easily and properly. They would also avoid in this way the getting of the different layers, which would give undesirable material, whereas they wanted the best. The dam is not very far from the railway station. The freight rate from Sacramento is, of course, an item, but just how large an item it is, I do not know. The freight rate from here down to San 5129
Mateo would be cheaper than from Sacramento to those points. That enters into the cost of placing equipment, and also keeping supplies coming, but from the railroad station to the Drum forebay there would not be anywhere near the difficulty of getting a steam shovel in as there would be from Millbrae or San Mateo to Pilarcitos. If you take a standard shovel into Pilarcitos the cost would nearly be prohibitive because you could not get it around those corners or bends of the road; when we took the second shovel into Calaveras, which is a standard 41 model, where the road is much wider than the Pilarcitos road, the curves have very much larger sweep, and are not nearly so sharp, and we had to cut off several turns. Both shovels were taken in on road wheels on the road from Milpitas to Calaveras. I understand the wages that were paid on the Drum forebay job was $2.50 for 9 hours. There is nothing to which I at- 5130
tribute the increase in cost of the Drum forebay over my estimate for the Pilarcitos. It is simply a case of work I had in mind in making my estimate of what Pilarcitos would cost; not having the analysis of the Drum forebay, I do not know that I could tell you why they are different. The work at the Drum forebay, and at Lake Arthur, and at Valley Lake, is substantially the same as was carried on at Pilarcitos and San Andres, except that neither of them had puddle pits. They selected the material, putting the select material on the inner embankment, and the coarser and less desirable material on the outer slopes.

The item of 70 cents includes that embankment. I presume there are extra auxiliary costs included; of course, it would make it more ex-
5131 pensive still if they were not included. The 70 cents is my estimate of the cost of building the embankment portions of Pilarcitos and San Andres, and I consider that it is a very close check. My estimate of 70 cents is intended to include the auxiliary costs outside of exploration, and the preliminary work that I spoke of, but is not intended to include anything above the superintendent or the foreman on the job. It is my understanding that the figures I have given in regard to the Drum forebay and Lake Arthur, and Valley Lake, are comparable, and that they cover the same cost. Mr. Martin did not give me the details of those figures.

SEVENTY-SECOND HEARING. DECEMBER 3, 1915.

Witnesses: F. C. HERRMANN for Plaintiff.
GEO. L. DILLMAN for Defendants.
J. H. DOCKWEILER for Defendants.

CROSS EXAMINATION BY MR. SEARLS.

I know that the unit costs on the Drum Forebay, Lake Arthur,
5132 and Valley Lake Dam, include the field costs and nothing else. They include the costs that ordinarily go with construction of that type.
5133 These costs that were given me are the field costs, but they do not include any overhead. I can compare these with my estimate on Pilarcitos, because I compare it as a whole, and as a finished job. That embankment, as a completed job, costs for field costs so much, and these structures are comparable to those structures which I estimated on the whole will cost so much. If I should find that the conditions of climate, location, freight expenses, and possible wage schedules are different from those I would expect to use at Pilarcitos, it would not be comparable; you would have to take into account those differences. I know something about the climatic conditions, and the wage schedule was the same, it was $2.50, and the locations are such as would increase the price for work at Pilarcitos. The snowfall is greater at site of these dams, but the rainfall is practically the same as that at San Andres, and less than at Pilarcitos. I have not examined the exact figures as to that, but I know in general, because I have studied
5134 hydrography all over this State in connection with the water investigation, and I know in a general way that there is very little territory where there is more rain than at Pilarcitos anywhere in this State. I expect you would get the same number of working days in a given period of time at the Sierras that you would at Pilarcitos, whether it is a matter of two or three years, or any number of years.

I am talking on the average. At this place in the Sierras I think the difficulty would not be great where the Drum forebay is. The Drum forebay is west of Emmigrant Pass but just how far I do not know. My recollection is that the station that is nearest to it was called Orel. 5135
It is my recollection that Spaulding is nearer Blue Canyon than it is Emigrant Pass, but not the Drum forebay.

Mr. McCutchen: My recollection is that Blue Canyon is 6 miles from Emigrant Gap.

Mr. Searls: I think that is about right.

Mr. Herrmann: The snow sheds on the Southern Pacific commence at Blue Canyon. That is, they figure it is economical to have snow sheds in there to keep traffic moving.

Questioned by Master. 5136

I do not know whether the Pacific Gas & Electric Co. kept their crew working there in the winter on the Drum forebay. The embankment there has not a puddle core. The material was placed and graded from the inner surface of the embankment where the water rested against it to the outer surface; the better material being next to the water surface, and it was all sprinkled and rolled after being deposited in fine layers, so that the method used, and the results of the embankment as a whole, are comparable with the embankment at Pilarcitos, excluding the puddle core. I think the benching at Pilarcitos must have shown the character of material on the inner face, but I do not know that.

Mr. Dockweiler: The benching was on the outer side of the dam, not on the inner side, and the addition was made on the lower side 5137
of the dam, while the dam contained water, and not on the inner side. The puddle was sloped toward the face as to that part which was raised, but the 20 foot widening was made on the lower side.

Mr. Herrmann: I think Mr. Dockweiler is correct. It probably was done that way by reason of the fact that they wanted to keep the reservoir full, or did not want to empty it while they were increasing the height of the dam.

CROSS EXAMINATION BY MR. SEARLS.

The Lake Valley Dam and the Lake Arthur Dam of the Pacific Gas & Electric Co. are situated farther up-stream on the same general watershed. I should say that the Lake Valley Dam was approxi-
mately 60 feet in height. The length of the crest, as I recall it, is 800 5138
feet. The Lake Valley Dam has a hump in the natural rock in the middle of it, and the 800 feet that I had in mind was the main portion of the dam. I think that the fact that it is 1500 feet in the record is a lower section of the dam. The Lake Arthur Dam was constructed from the material that was available on the ground, being a material of a sort of reddish cast, containing some pebbles. I think there was nothing unusual about the construction of that dam. I do not re-

member where the borrow pits were; they were pointed out to me at the time, but I simply have a recollection that they were not a great distance from there. The longer the haul from the borrow pit to the
5139 base of the dam, the greater would be the cost. It would require more teams and more equipment to keep the work going. Of course, the same shovel, and the same plow would do the work in either case, but it would simply be the matter of haul. The Lake Arthur Dam did not have as many pebbles in it as the material of the Valley Lake Dam, which was practically the same type of material as the Valley Lake Dam. I do not know whether it was necessary to do blasting in the construction of those dams. In the matter of haul, the higher the dam, usually the greater the haul. By reason of the fact that the higher dam occupies more space for a foundation, and you must keep your borrow pits a reasonable distance away from that base.

These dams, with the exception of the Drum forebay, were not as high as the Pilarcitos or San Andres Dams. The Valley Lake Dam was 63 feet in height, and the Pilarcitos was given as 70 feet in the schedule, and the San Andres as 95 feet. The Alamo Dam, in the
5140 Imperial Valley, was about 40 feet high. The material in that was handled with scrapers, and was obtained from the banks at a level with the crest of the dam. Most of the material was hauled down hill directly with Fresnos, without the use of wagons. We paid $6.40 for a four-horse team Fresno and driver down there. I do not know what was paid at the Pacific Gas & Electric construction for stock. We were paying, during the time I was engaged in the Calaveras construction, $12.50 and $15 a month per head. My recollection is that we paid Desmond for his 80 head $12 a month, or $12.50. That would be $25 a span, and is where we kept the stock, and paid for it whether it was idle or not. On the prices that I gave you in the Imperial Valley, the owner took the risk of the stock being idle. I do not know how much of a saving we made in the Imperial Valley by being able to Fresno our earth without the necessity of steam shoveling, or putting it into wagons. There was no puddle core in that dam, as there
5141 was no chance to select the material. It was all silt, and the dam was as impervious as we could get it with the material that we had.

Questioned by Master.

That is the trouble down in that country, and that is why we had to reconstruct a great deal of the levee on the Colorado River, for the reason that we did not have puddle pits.

CROSS EXAMINATION BY MR. SEARLS.

We did not feed the stock in the Imperial country, but in the Calaveras we did, and took care of it also. The stable accounts there show that taking into account the rents of the stock, and of the wagons, the feed, shoeing, harness repairs, and things like that, it cost $1.25 per day, including the wagons.

In the Modesto District I did not see how the Dallas-Warner fill at 45 cents a yard was done; it was done prior to my connection with the Modesto District, but it has been explained to me by the engineers and contractors who were on the work, and they described it in this way: The material was borrowed from borrow pits at either end of the dam, and was hauled by cars from there, and dumped in on the two toes of the dam, much in the same way in which the Haiwee Dam was built, but with a smaller equipment, because it was a smaller job. The central portion of the dam was occupied by a pond 5142
of water, and this material was dumped and allowed to roll down into that puddle of water with the idea that it would in that way become puddled. As a matter of fact, what happened is, that it became separated, and they had a series of layers, some of which were coarse, and some fine, which was largely responsible for the trouble that they have had with the dam. There was no puddle. That was Dam No. 1 of the Dallas-Warner Reservoir, which had a maximum height of about 40 feet. That cost 45 cents a cubic yard put in in that way, but if they had had a proper puddle, the cost of the embankment would have been materially different. They should have rolled the embankment, and they did not. They should have selected the material, and taken the better material on the front face, and the coarse material on the rear face, instead of mixing it as they did. It could possibly have been done by cars, but it is very difficult to carry material on to a dam with cars, and roll it, because you have got to be moving the track all the time. They worked 9 hours, and I think the basic wage schedule was $2.25.

The steam shovel material in the Calaveras cost 53.4 cents a yard in place. That is on the basis of a 10 hour day, with $2.50 a day, 5143
without any rolling or selection of material. I make a separate cost for rolling of 15 cents, which covers also sprinkling and spreading.

Questioned by Mr. Dillman.

I do not know whether Beard had this Dam No. 1. I believe part of that payment was bonds and part of it was cash. The Modesto six's are at par, and the Modesto five's are at 92 or 93. That work was partly paid for in Modesto five's, and I rather think that the 45 cents does not represent the cash price of that work.

Questioned by Master.

They never paid for a contract with bonds directly. It always 5144
went through a third party. Very often they make the arrangement with the third party to buy the bonds, and presumably the contractor allows for that discount in his prices.

CROSS EXAMINATION BY MR. SEARLS.

I do not know how much of the 70 cents embankment cost on the Pilarcitos represents labor charge, but I judge would be around 30%, which would be, say, 20 to 25 cents of it labor. Of course I used the

prices that obtained at Calaveras, which included material and repairs, and equipment and stock as well as labor. I would say that 25 cents a yard would represent about the labor portion of that work, based on an 8 hour day. If you were to resolve that into a 10 hour day, the labor cost would be reduced 20%, and if the labor cost is 25 cents, it would be about 5 cents a yard.

Mr. Dockweiler: I was a contractor to supply the engineers and surveyors as to San Joaquin Irrigation District work, and I received
5145 cash plus 25% for the work of supplying these men. That was brought about so that the bonds could be sold at a discount of 20%; the discount of 20% was the same as bonds at 80 plus 25. That was the South San Joaquin District when it was started, and will give you an idea of the way that was arranged to dispose of the bonds, and yet enter into contracts for cash.

CROSS EXAMINATION BY MR. SEARLS.

Some of the work at Calaveras was very much in a rush while I was in charge of it, because we had to have the flood water conduit finished in order to take the flood of that season. On the embankments of the dam, we worked along at a rate not as fast as could be worked. There was one shift sometimes, and sometimes two shifts. They are working one shift now, though they have been working two shifts some of the time. Mr. Elliott and I have gone through the daily reports of the steam shovel performance since March 23rd of this year to November 30th, and the percentage of time lost of the
5146 possible shift was 23.12 percent. That is a particularly good period, and very few delays have been due to rain. If it were in the rainy period, the percentage of delays would be larger. There was rain in the early part of this year, but it was of light, drizzling showers, and the crew was able to work, where they would not work if it were a downpour. I figured in the construction of the San Andres and Pilarcitos, that you would not get any greater efficiency during the working season than we did get in Calaveras. These figures are the basis of the shovel performances that I have assumed at San Andres and Pilarcitos. On the face of this record I disagree with Mr. Hazen in his statement that during the summer months you ought to get nearly 100% efficiency at San Andres and Pilarcitos. That is, so far as the 100% estimate of the steam shovel would be concerned, and I do not think that was what Mr. Hazen intended, because that isn't possible.
5147 A steam shovel never runs 100% of the time; there are always delays of one kind or another, due to repairs of machinery, whether it rains or not.

Questioned by Master.

I have found in most all work that your percentage of delays will run from 25 to 35 percent, due to causes that are normal. For instance, in the sluicing of the Freeman Dam site, I kept a very accu-

rate tab on the time lost due to various delays, loss of power, or to moving the nozzle, or to the fact that the sluice boxes became clogged and had to be cleaned out, and that the pumps would have to be repaired, the motor repaired, or those things that are incident to a job, and that amounted to about 33 or 34 percent. 5148

CROSS EXAMINATION BY MR. SEARLS.

Out of a possible number of working hours of 3,490, we worked 2,681¼, so that the loss in that time was 808¾ hours. In other words, the daily report sent in show that the steam shovel was delayed an hour for this, or half an hour for something else during that day.

Questioned by Master.

I do not include Sundays in the possible hours. By "possible hours", I mean the hours on the shifts that were worked; the night shifts are not in there except when we worked night shift. Every so often you have to stop and re-roll the tubes of a boiler, or make repairs to the feed pump, or various things in the machinery where the equipment has to lie idle for all the way from a few hours to two or three days. Those repairs are done on Sundays to the extent that they can be, but where they cannot be done, it constitutes this percentage. This is practically a new shovel that we put in there, but this is on both shovels added together.

CROSS EXAMINATION BY MR. SEARLS.

The construction of the main Calaveras Dam commenced about July 1, 1913. The rate of construction of a hydraulic filled dam, as compared with the rate with which puddles for a dam can be built, 5149
depends upon the character of the material, and the availability of your water supply for sluicing, and the rate at which you can utilize equipment on the puddle core dam. On the average, I should say that you could work faster with a hydraulic filled dam than you could with a puddle core dam, but that would depend so much upon the conditions, that it would be impossible to say. The height of the Calaveras embankment today is something under 100 feet.

Questioned by Master.

It is probable that if the company had not had any of this litigation and condemnation proceedings and so on contemplated by the City, that the Calaveras Dam would have proceeded more rapidly. The steam shovel costs that I cited are based on this year's operations, and they made practically the same performance in 1913 and 1914. The steam shovel work has proceeded with normal rapidity. The total construction of the dam, of course, includes the sluicing, and these various things that I speak of. I do not think that the final costs on this dam will be higher than they might have been, as my experience is that the more you rush work, the greater the cost.

5150 CROSS EXAMINATION BY MR. SEARLS.

Depreciation and interest on equipment does not enter into field costs. The depreciation of equipment really depends on the material handled rather than the character of equipment. The interest on equipment isn't the field cost; that is interest during construction, and is an overhead. I think most of the suggestions made by Mr. Mulholland have been followed out. Perhaps in the matter of sluicing he suggested that we put in other units.

5151 The stripping on the Freeman Dam proceeded as fast as we could do it. We were working under pressure, because Mr. Freeman wanted these results in order to get at his design, and he was pressing us to hurry the exploration work along as fast as we could. The work done in 1913 on the Calaveras Dam was done just as fast as it could be, because we had to get the storm water conduit finished before the floods began, and we worked night shifts a good deal on that. That had nothing, whatever, to do with the embankment. The steam shovel on the embankment has proceeded at normal speed, and they have gone as fast as they could. There was no delay due to the disputes with the City, in regard to the embankment.

5152 Mr. Hazen: I should say that the company had used to a pretty fair capacity all the equipment that they ever had. If they had had the money, and wished to prosecute work faster, it could have been prosecuted faster, but to do that, would have involved a corresponding increase in equipment. I do not believe that with the equipment that they had they could have done a very greatly increased amount of work over what has actually been done. I do not think that they would have done better with that material, even had they a larger dipper for the steam shovel. If they were loading railroad cars, you could use a larger dipper, for wagon work, I should think the dipper was right. The materials here are not comparable with Southern California; it is a great deal harder digging in Calaveras, and where the digging is harder, the economical size of the bucket goes down. The work at Pilarcitos is an entirely different kind of material from that at Calaveras, and as to which is the easier of the

5153 two would depend upon what you were talking of at Pilarcitos. You have scattered pockets of loose material that would be comparatively easy digging, but which you probably could not excavate with a steam shovel on a good face, working right along. Then you would have the larger materials, which perhaps could be worked, although that is not demonstrated in the way that is being used at Calaveras, of blasting the rock and taking the blasted material, and working it into a dam. I think probably that could be done, but I do not consider it demonstrated.

Mr. Dockweiler: Those loose pits were in the nature of clay pits, but the two large pits from which the main embankment was constructed are in evidence today, and all you need in your mind's eye

is to take the materials in the dam now, and put them back, each in its proper proportion, and you will note there are no spoil banks below that. From the information given me by the contractor, and everything that I could learn, there was no powder in loosening the material in these pits on the bank, and hence, as I view it, steam shovel work can be proceeded with very advantageously, and especially so at the San Andres, because there is a wider condition; the bench shows further the way they put in with the old carts.

Mr. Hermann: I disagree with you entirely on the borrow pits at San Andres. I think you would have to shoot them to use a shovel in them, and I think the same thing is true at Pilarcitos. I notice that one of the borrow pits pointed out has a pine tree in the middle 5154
of about 20 to 24 inches in diameter, so I doubt whether it is a borrow pit or not, and it looks to me that if you were to get the soft, friable material, you would have to move your shovel around a great deal, and it would not pay, and it would be more advantageous to go into the country rock, which is soft in character at Pilarcitos, and shoot it and then shovel it. I think it would probably cost less than picking a little here and there with a steam shovel.

CROSS EXAMINATION BY MR. SEARLS.

You would have to blast practically all the material at Pilarcitos, because I feel that it would be more economical to utilize the material that could be blasted in one pit, rather than to move around all over the country getting material that would not have to be blasted, because moving the shovel around from one pit to another is a very expensive operation. My allowance per cubic yard for blasting is 8 cents at Pilarcitos. The cost of blasting per cubic yard in Calaveras for that embankment has been 13.9 cents. The trench in the Dry Canyon Dam, on the Los Angeles Aqueduct, was a deep one, cut in alluvial material, mostly with water in it. The cost of $4.07 per cubic 5155
yard there is not so very much higher than the Haiwee; they had more water to contend with in Dry Canyon than they had at the Haiwee. At the South Haiwee they went down quite a depth before they hit any water, and then it was in amounts that could be handled readily by small pumps. In Dry Canyon trench there was considerably more water, and I presume that that is the reason the cost is higher in Dry Canyon than in the South Haiwee. As I understand it, both of them were timbered. I could not say as to whether the Dry Canyon was very narrow in trench, but the Haiwee, which I went to the bottom of and examined all the way, was about 8 feet wide in the clear.

The bid for the excavation on the Modesto District was $4 a cubic yard. That work is to be done at Dam No. 1 of the Dallas-Warner Reservoir. The $1.54 at Calaveras on an 8 hour day was a labor charge for trenching. The cost, based on a 10-hour day, was $1.93. Ad- 5156
justing that whole cost to an 8-hour day made it $2.32. That trench

was wide and shallow, without timber. I have never built any puddle core dams, and have never had any personal experience as to the cost of the puddle, except as you get it in puddling around structures.

Dillman

Witness: GEO. L. DILLMAN for Defendants.

DIRECT EXAMINATION BY MR. SEARLS.

I would add to the cost at Pilarcitos $6,920 for lagging, and at San Andres $5,400 for lagging. I have not figured it for a cubic yard. I figured the timber work 173,000 feet B. M., at $40 a thousand. To
5157 run the lagging into the trench cost would add a little over $1.

Mr. McCutchen: That would make Mr. Dillman's figure for trenching $2.08.

Mr. Searls: Yes.

Mr. Dillman: At San Andres, the yardage is 13,528, and the lagging $5400. I assumed that was a shallower trench, and only lagged 20 feet; the other one would be lagged for 30 feet.

Mr. Searls: I make it 40 cents a cubic yard to be added there. That would make his total figure 90 cents on the San Andres.

CROSS EXAMINATION BY MR. MCCUTCHEN.

Referring to Pilarcitos; there should be a public core, earth dam, of the size indicated in the schedule; the puddle being sufficiently in contact with natural materials to make a dam, the bases being of earth, as shown in the schedule, sufficient to support and protect this puddle wall. In a general way that describes the structure, the cost of which I have estimated at Pilarcitos. The puddle wall would be made of selected material, partly clay, that was so moistened and compacted that it would be impervious, and the protection sufficient to
5158 keep it from drying out. I would select the material for that purpose, and would take any clay material that would not have ingredients, such as roots, too coarse stuff, rock, and wood. Small pebbles would be the smallest rock that I would have in it. I would take none of the surface material, but any of the material under the surface that had no roots in it, and was not too coarse, and that contained sufficient clay—20 to 25 percent of clay—would make good puddle if properly handled. I would remove that surface material to a depth sufficient to get rid of the objectionable stuff in order to get at the clay. The objection to soil would be more from the possible vegetable matter than from its own nature. If you were able to get rid of the roots and other vegetable material, I would use the surface soil for
5159 my puddle core. If it were convenient to get enough material from the surface without going down to hard material, I would take that for puddle core. After getting the material, I would wet it and puddle it in a variety of ways. For the price I have given I should pre-

fer to do it with animals. I would wet the material down in place, and have it quite wet, and lead animals back and forth through it for the purpose of compacting it until I was satisfied with the puddle. That is all that is necessary for the purpose of compacting it. As I was making my puddle core, I would be carying up the inside and outside of the dam at the same time. The material would be thrown in 5160
loose, and would be somewhat compacted in handling by the animals and wagons going over it. I presume it would weigh somewhere between a ton and a half and a ton and three-quarters to the cubic yard after it had been dumped in, and the animals had gone over it.

It would be a little less in volume after it was dumped and the animals had gone over it than it was in the borrow pit. It would be as compact weight for volume in the embankment as it was in the borrow pit, but it would shrink some. The matter of shrinkage is a matter of considerable dispute among engineers. I know, from having measured up about 100 miles of borrow pits and cuts and bank, that the yardage will be a little bit greater in excavation than it is in embankment immediately after the embankment is made. The ma- 5161
terial would occupy a smaller space in the embankment immediately after it is placed there than it occupied in the borrow pit. When the puddle wall reached the top of the dam, and the two sides were built up so as to be of equal height with the puddle wall, it would not be a homegenous mass. I do not think this work was a homegenous mass immediately after its completion. If you have provided for the wetting of the material from side to side and the rolling of it, I do not think it would be a homegenous mass when completed, but I do think it would have been more homegenous than the structure which I have computed the cost of. I do not know about the history of this. There was nothing in my information to indicate that this was carried up in any different way from what I have described.

In the case of a dam, I would depend on the puddle wall, or on 5162
compacting by depositing in layers, and wetting and rolling, but I would not depend on two ways of tightness in any structure. The only earth reservoirs for supplying the large cities that I know of are these two in this estimate, and the Chabot Dam. I think they were all built with the puddle walls. Either the puddle wall was necessary, or the compacting of the general material of the dam was necessary, but they were not both necessary. I do not think that the methods employed in building the dykes in Holland would have been prudent in these locations in building dams for the purposes for which these were built. I did not say that the dykes in Holland were among the best ever built, but I said they were among the most important dams ever built, but they seep considerably. I do not think these structures, built as they were, are one cent better than the ones I have provided for in my figures; they cost more money, but they do not do 5163
the business any better. In accounting for the fact that engineers who

have built dams have not used my methods, I do not want to account for anybody's else actions but my own in this world. I am not sure that I am surprised that other people have not followed my methods, as they have not in a great many other particulars. I do not know of any case where my methods were actually followed for a city water supply.

Mr. Dockweiler: The Central Reservoir was built without a puddle core above the base. It is in the City of Oakland, and if it burst it would do great damage. It was rolled and was compacted, and the
5164 rolling was a very important part of the work.

Mr. Dillman: There is not a question but one method or another for tightening an earth dam is very essential.

CROSS EXAMINATION BY MR. McCUTCHEN.

After this structure that I have designed was brought to its actual height, there would probably be a little unequal settling, but not enough to cast a suspicion on the integrity of the structure, or enough to disturb the puddle. In a dam of this height I think that settlement would probably be 4 or 5 percent. The puddle wall would also settle some. The puddle wall, and the two sides of the puddle wall, would not be independent of each other. This settling is a very slow process, and extends over a considerable period of time.

Very frequently in railroading an allowance of 10% is made for
5165 shrinkage, but 10% is the maximum that was ever added to railroad banks. It was a crime to do it, because they never settle 10%. I have measured hundreds of miles of them. I put that 10% shrinkage on about a 60 mile division of railroad line, and some of the banks were very heavy, and some of them 60 feet high. I built them up the extra 6 feet at the expense of the contract. We didn't lay track that year, but the next year we decided that the shrinkage might as well be cut off, and we had to refinish the banks for the purpose of track laying. That had settled a year then. I went over it and set grade stakes for the cutting of the shrinkage that had not shrunk, and on a 60 foot bank I had plenty of room on both sides for a side-track. The banks did not shrink 10%, and no banks put up with reasonable material ever did shrink 10%. I am well aware of that 10%, and it is not in use today.

I didn't request any special plans of this work. I was given plans, and I was given this schedule, and an inspection of the work and the schedule was all that seemed necessary. I did not know the depth of the trench in which the puddle core was laid below the surface until
5166 it came out in the evidence here, and it was not important that I should know its shape and its depth for the purpose of this estimate. I did not make any inquiry to determine whether it was a deep trench or a shallow one, and I do not think it was important for me to know that fact. This is a small item in connection with a large estimate,

and an error in that of considerable moment would affect the total by a very small amount. This estimate of mine, in all of its particulars, is not specially exact; the estimate as a whole is a much better estimate than in these small particulars. If I wanted to go into all these 5167
particulars, I could not have made this estimate at all. I think that all the errors are covered by the percentages added. The matter of not having these plans in this particular is not a serious matter at all, and I do not think that my estimate is an estimate within possibly $100,000. It may be half a million dollars of the final result, but all that difference would be covered by the diminution, or the increase of contractors' profits, and for that reason I did not find out the plans of this particular trench, or of a great many other particulars.

My estimate of the cost of this trench was $1 per cubic yard, and if the trench was lagged—and I do not know yet that it was—it should have appeared in the inventory as an item of timber which I have added in that way to make it $2.08. It is contrary to my practice to estimate lumber by the cubic yard. My assumption was that it was not a lagged trench. The material being loose rock, it 5168
might have stood without lagging. I do not know that it did, but at the time I made this estimate, I considered it unlagged trench.

Mr. Searls: I suppose it may also be stipulated that the drawings which were furnished do not show that it was lagged.

Mr. McCutchen: I imagine that that is the fact. I do not think the drawings would show whether it was lagged or not.

Mr. Dillman: The question of lagging or not lagging did not make much difference, because if the trench were not lagged, there would have been more excavation ordinarily. I did not assume in this case that the trench was not lagged, and at the same time 5169
assume that more material had to be excavated than was suggested in the inventory. The size of the trench was not a part of my information; the yardage in the trench was a part of it. The sole object of lagging is to avoid added excavation, which would be necessary without the lagging. Very few trenches in soft material and water can be dug very narrow and deep without lagging. I assumed that there would be water encountered in digging this trench, and there would have to be some pumping done. I have been to Pilarcitos 5 or 6 times, and have spent there in the aggregate something inside of a day, or ten hours. I went over all of the properties that I could, and over some of the flume. I went down to the Stone Dam and below it. At the dam and in its vicinity, at Pilarcitos, I spent less than a day. While there I followed the flume on the west side 5170
of the dam up the gulch. I saw some trestles there, and I walked across one or two of them. I saw some borrow pits below the dam, and up a gulch to the southwest of the dam, and also there are some borrow pits on the east side, but the location of them was not as important to me as the material of the sidehills. It is alluvium

material that could be handled very easily with a steam shovel, and possibly a small amount of shooting. I went into the gate tower, and inspected the wasteway. Part of the borrow pits were so located that you had a down-hill haul, and some of them had an uphill haul. Possibly 20% of the material would have to be hauled uphill. I think the haul would be on the level in a good many cases.

5171 If I had had any plans of those structures, I could have gone into more details with probably no better result. Referring to my figure of 40 cents a yard for excavating, loading, etc., and finishing: The dumping would be in lumps, and it would be better to spread that material evenly than to leave it in a lumpy condition; it would shrink more evenly, and it would also facilitate the handling of further material to have it in shape. I would use on that what equipment I had, or was available. I might use a yard bucket, but I would not be hide bound about that. I would expect to get some ¾ of a bucket full to a bucket full with material of that kind. If you broke that material out with the use of powder, I do not think it would come out in very large pieces. It is a fairly friable rock, and I think it would be fragmentary. The effect of powder is not to blow wet

5172 material into dust. There would not be much powder necessary there. I saw the sides of a borrow pit, and examined the sides of the hill, but I didn't make any test of the pit, nor is it necessary for this kind of an estimate. This is a contractor's estimate. I am bidding on this work, and am willing to take at this price, and would like to get it. I know that I could not take this contract, and I know that it is not within the possibilities that such a contract can be let, but I made the examination from that point of view. The point of view of an examiner of property of this kind is most important, and it is not meaningless for me to say that I would take a contract to do the work for that figure.

This trench could be done with a derrick. In doing it for $1, it depends entirely on how loose the rock was. I would start it with

5173 a plow, and probably finish it with a pick. Whether I would use any powder would depend entirely on the hardness of the rock, but if powder were economical, I would use it. My figure of $1 does not contemplate the use of powder, and yet it would cover some powder if it were necessary to use it. It would not cover the excavation of hard rock. I assumed that I would not, in going to that depth, encounter any hard rock. My assumption was solely from the inventory. It says "loose rock"; loose rock is not hard rock. I understand that it is rock that could be removed with a pick and shovel from that. I would get the first of the material out of the trench with scrapers, and if the trench were of much depth, I would get the rest of it out with derricks. I assumed that the trench averaged 30 feet in depth. It is perfectly possible to excavate and haul out

5174 of a pit of 30 foot depth by building runways out of it. The run-

ways would come in with the cost of excavating the cross-section of trench if I used that method.

Leakage in earthen dams is quite common, and is due to the 5175
manner of construction. A dam built in the way I have suggested would very probably leak. I do not know that the Pilarcitos and San Andres Dams leak. The rule is that dams leak, but many leaky dams are entirely safe in spite of the leaks. The only detriment in most cases of leakage is the loss of the water. A small amount of leakage which comes out clear water is practically no detriment to a dam. When the leakage occurs in such shape that it is cutting, and comes out a roily stream, it is something more serious, and should be looked after. Most earth dams of my acquaintance that do leak, leak in such a way and in such an amount that the leakage is no detriment. The expense to make those same dams tight would be an unwarranted expense in ordinary construction. Earth dams often tighten up and stop leaks after water is turned in and they are leaky at first. I presume—although I have no evidence—that was the case with these dams. It would be very difficult to expect to encounter material that was so impervious as to stop all water, all seapage, and all leakage in a new dam. The Crystal Springs Dam leaks, and that leakage is absolutely no detriment to the dam. I do not know 5176
whether that leakage exists now or not. I think the leakage that is most evident is probably through the country rock at the southern end. If this dam, in the way I have dealt with it, should leak, I would not be disappointed. I would consider it good engineering to construct, in an earthquake country, for the use of a city depending upon it for a water supply, a dam which would leak when completed, if the leakage were not excessive. The leaks, if they would be serious, would develop at first, and not later, and would probably be lessened with time. The time of the first filling would tell whether it would leak or not so as to be harmful. The dam which I have provided for would settle, and though the core wall would settle with the two sides, it might not settle exactly with it, but it would settle.

Mr. Hazen: I would contend that a good dam would not settle. 5177

Mr. Dillman: An earth dam of that height would settle, and I do not believe that an earth dam of any height that amounts to anything was ever built that would not settle. I did not say that I did not know of any dams that were built as these three were built. I understood your question to be in connection with a large water supply, and the other method used in the building of dams. I do not happen to recall any other dam now but those three constructed in the way in which they were constructed. I think all earth work, put up in large volume and to considerable height, would settle. While compacting will partially lessen the amount of subsequent settlement, it will not avoid it entirely. I have had experience in

5178 compacting material in building small reservoirs in towns where I wanted lining, and where I wanted to have the lining unaffected by the settlement, I compacted it. In my experience, compacting has never been done so as to result in such a compact structure that it would not settle after it was finished. I do not think it could be done.

Counsel for Plaintiff read a portion from a report made by Mr. Schussler to the directions of the Spring Valley Water Works, in 1867. These copies were furnished by the Secretary of the company on November 28, 1905, and were copied under Mr. Dockweiler's direction, by H. G. Leonard, Minna Street, San Francisco, California, as follows: "The lower or main dam contains at the present date "about 275,000,000 gallons, 200,000,000 of which are available with- "out pumping. This dam, whose water slope was too steep from the "start, has, during the last two months gone to work itself to remedy "this fault. The whole slope, by the combined action of the puddle "pit inside, and the water outside, is working itself more and more "to a natural and gentle slope, and I consider the dam a good deal
5179 "more solid and safer now than it was last winter. As soon as the "water comes up this winter, we shall fill the deficiency caused on "top by the settling."

Mr. Hazen: I should call that, knowing nothing about it except what has been read, a slip.

Mr. Dockweiler: Mr. Schussler told me this himself: That that puddle originally was made too wet, and the banks were not strong enough to hold the pressure, so the material widened out and was squashed out. I termed it a slip, due to the excessive weight of the wet puddle.

5180 Mr. Hazen: Well, notwithstanding that he uses the word "settling", I should think that the context indicates that it was a slip.

CROSS EXAMINATION BY MR. MCCUTCHEN.

To get my steam shovel into Pilarcitos, I would pick out as smooth a route as I could, and haul it in there on its own wheels. I think I would modify the present road. The gage of a steam shovel is 4 feet 8½ inches. I would use a track shovel; just what it would weigh I do not know.

RE-DIRECT EXAMINATION BY MR. SEARLS.

5181 The Vallejo Dam, I think, was built without a puddle, and it furnishes water to the City of Vallejo. I have not seen it since it was built, and only know of it by description. I think the Tabeaud Dam was built entirely without puddle; it is a compacted dam, and a very good one. I think I have heard that it did not leak. I have read a description of it some years ago, and I think that description showed a very safe structure, with no puddle at all. It is above the

town of Jackson, Amador County, and on the same drainage, so that a disaster there would wipe out the town, and it was imperative that that dam be constructed safely.

RE-CROSS EXAMINATION BY MR. GREENE.

I think the Vallejo Dam did leak a little. The San Leandro Dam leaked for many years, but I think it is tight now.

Questioned by Mr. McCutchen.

I think the Vallejo Dam is just as good a dam as the Chabot Dam. It would depend upon the amount of money at my command whether I would build a dam for supplying a large municipality 5182
with water by the use of the methods employed at Vallejo, rather than those used in the building of the Chabot Dam. If I had plenty of money, I think I should have spent some extra money on the Vallejo Dam, but at the same time, the dam holds water, and if it holds the amount of water intended, it is just as good a dam as can be built, and there is no reason to build it any better. Dams do go out sometimes quite a long time after they have been built. I know of no instance where an old earth dam went out in any other way than by overtopping, or by the action of squirrels.

Witness: ALLEN HAZEN for Plaintiff. Hazen

DIRECT EXAMINATION BY MR. MCCUTCHEN. 5183

Earth dams have gone out by undermining where there was seepage underneath that has gradually increased. It has resulted from the improper construction of the dam. The Lyndebrook Dam, at Worcester, Mass., is a noted case. There was a good deal of damage in that dam, and it went out in that way. I do not think that ever showed roily water; it was a defect in the construction—in the material—and it gradually got soft, and then became quick-sand, and finally it became fluid, and flowed out and let the water out. I should hope that a dam built under my plans and supervision would not leak. Dams do leak, and I should not think that it was absolutely certain that one that I built would not leak. I suppose I am more or less familiar with at least 100 earthen dams, forming parts of municipal water supplies in this country and elsewhere, and I should think that half of them leaked more or less seriously. The reason they leaked in most cases is that the people who built them have not been willing to take all precautions that they ought to have taken to build them tight. By leaking seriously, I mean that they 5184
leak more or less at the present time continuously. It is serious because they lose water, and how serious it is depends, of course, upon the situation, and how valuable the water is.

I should say a well-built dam would not settle appreciably. I

do not know that the fact that it settled a little would necessarily be a serious defect. The Borden Brook Dam, I am satisfied, had no settlement whatever upon its completion, and I think that has generally been true of the earth dams that I have been familiar with. I built masonry structures—the fills built in the same way as dams—
5185 where the fills have been as high as 30 feet, and where precise levels have been taken on the masonry for a period of a year or two after construction, and where a settlement of a quarter of an inch would have been detected if it had been there, but it has not been there. That represents a fairly heavy loading on top of the embankment, so that I know that it is possible to build fills with good materials that will not settle.

Questioned by Mr. Searls.

Those fills were built by rolling and sprinkling, and I do not think it is possible to build a fill without doing that, so it won't settle.

Questioned by Mr. Dillman.

This is the condition: A masonry tower comes up near the middle of the dam from the bottom from bed-rock, and that is, to some extent, independent of the dam. If there had been a settlement of an inch, I think it would have been apparent where the dam comes against that masonry. There might have been a quarter of an inch settlement without it being detected. We have to build the tower inside the dam, instead of outside, as was done at Calaveras, because if we built it outside, the ice would throw it over in the
5186 winter.

Dockweiler Witness: J. H. Dockweiler for Defendants.

CROSS EXAMINATION BY MR. McCUTCHEN.

I would use 1½ yard buckets on that work. The size of the steam shovel used on the Central Reservoir work in Oakland was 2½ yards; it may have been 2, I am not positive about that. All shovels having a yard and a half bucket do not have the same horse-power. I didn't go into the horse-power; I simply took a shovel that would cost you $8,000. I didn't go into what power the machinery connected with that shovel would have. I don't remember picking out any model of shovel. I simply allowed $8,000 for a shovel that
5187 would have a capacity to handle a yard and a half dipper, and the weight would be roughly about 40 tons. I would start and have that shovel cut its way along that road, and throw it over the bank, in order to get it in there. That is the way they built roads in Southern California for the State Highway. On the Castake Road that is being built there now, they have a shovel on that throws the bank right over. I have estimated this shovel carefully. It is in the inventory,

and fully allowed for. Then add $8,000 over-time that would be lost in the endeavor, and you have a sum that would make the contractor rich. The length of time of getting in the shovel I have in my allowance for interest and overhead. I would get my shovel over on the road that is there now, and I would do everything I could with a shovel. Then I would smooth that over with other work, and there is an allowance for that. That road has been listed at so much per yard in the inventory, under the heading of roads. In addition to cutting that road, I have made an allowance of $8,000 to get the shovel in and out. The road I am assuming to cut is the road from San Andres to Pilarcitos, and there is a very small section as you leave the San Andres Dam. As you leave the San Andres Dam you commence a climb somewhat steep, and get to the summit, and then you go down a steep grade into open country, and then you go through the San Mateo Valley; there is quite a good, smooth space 5188
there, with no brush or anything in it. Then you climb up the hill and go to the divide, after crossing which you get into the Pilarcitos Reservoir; then you cut your way down. I have measured that road, and have classified the nature of the material in it, and that determination as to yardage and classification is set forth in the schedule.

I didn't go into the range of prices of steam shovels. I have observed the work of steam shovels a great many times, but beyond observation, I have never had anything to do with steam shovel work myself. With reference to work done by the Peoples Water Co., in 1910, I do not know the elapsed time from the beginning to the end of that work, but I should say that 208 days is about right, and that the number of days worked was probably 159, and the number of days lost, and for which the crew was paid was 49. The engineer and the crane man, and the fireman and the runner, I have allowed 5189
to go right on. They are a charge by the month; when you lay off, you lay off your pit men. You always have 4 men on your payroll whether your shovel is working or not. I know that is a fact from the books of the Peoples Water Co. That is what they pay in Los 5190
Angeles, because they always have work for those laborers at some place else. I know this much, that nobody is drawing pay in Los Angeles that is not performing work, and I have gathered that from conversation with the men. I have engineers working for me who have done a great deal of steam shovel work, and they know the procedure and the custom. In the Peoples Water Co.'s work, the contractors got 15% on every dollar expended, and if there was an excuse to put a man on, he would have been there.

I do not recollect what the material was in the building of the Dry Canyon Dam. I should not say that it was sandy material, 5191
because the pits, I think, are within the basin or the reservoir itself, and they were some distance up-stream from the dam site. The information from Mr. Jacques was relative to steam shovel work on

the Franklin Canyon work. They were working in two kinds of material; some hillside material which runs into shale, and some material in the bottom which is very favorable, beink kind of alternating layers of gravel. It was the Franklin Canyon material in which they were working during the period covered by that record. I recognize a difference in material, so far as the ability to do steam shovel work rapidly is concerned, and I have made the deductions.

5192 I have recognized that by making an allowance, and cutting down the output. I assumed that the dipper of 1¼ yards was filled every time in that Franklin Canyon work. The dippers were heaping full, and would hold fully a yard and a half, because you have all the space above the bale, and the space at the teeth would protect you. Sand material would peak to the least extent. Sand would compact, and there would not be anything lying over the top. There are voids in the dipper, but I am taking it as it runs. This material compacts down to 2 yards, and where you have 2½ yards in the wagon, you will compact it down to 2 yards in the dam, and get about 20% depression. That is not in all sorts of material.

5193 I said the number of loads in 8 hours was 384, and Mr. Jacques' record shows 691 cubic yards placed in the dam. That would show blocky, bulky material, and would not give you a very good loaded bucket. On the computation of 1.79 cubic yards to the load, it shows considerable void. I have not made the computation where the 598 loads resulted in placing 1,076 cubic yards in the dam as to the number of cubic yards to the load. I do not know any reason why in the one case my record shows 1.79 cubic yards per load, and in the other case 1.63. That work was presumably in the Franklin Canyon. That is where I met the man and asked him for the record, and he

5194 sent it to me. I do not think this relates to the upper dam in Franklin Canyon at all, because that was begun, I think, after this data was given me. I went to both the dams, but at that time I do not think they were doing any work on the Upper Franklin Dam. The upper dam was built by wagons, and my recollection is they were loaded with a shovel, and the material was hauled on to the dam, and compacted by the wagons themselves. There was no rolling apart from that given to the material by the wagon wheels. The Lower Franklin Dam was part of it put in by wagons, and part by hydraulic fill. The upper portion, of the side nearest the water was built by wagons hauling the material on to the dam and compacting it. It may have been by wagons and scrapers. The addition is now being made by means of hydraulic process, and in that process the material is excavated by the steam shovel, transported a certain distance and dumped, and a stream placed on that dump which gradually washes that material to a sump; at that sump it is taken by a pump

5195 which transports it a certain distance. Between the first pump and the dam, a second pump is introduced to give it the additional lift.

The water is forced on to the dam through a pipe, and this pipe is carried to different portions of the dam just as the requirements call for material. The pipe empties at the edge of the embankment.

That was a solidly built dam, and there was strong compaction 5196
there. I tested it myself. There was a great point made in a certain proceeding where Mr. Mulholland had been a witness, to the effect that you could not compact a dam by wagon rolling alone; he called my attention to this particular work, and the soil was thoroughly compacted, and to the extent that it was built, it served as a dam, and it impounded a little water, but was not of the width that he wanted it. It was a perfect dam as far as it had gone at the time I saw it, but it was not wide enough. They wanted to build a core, and elected to build it by the hydraulic process as against the ordinary methods of building it. The dam was all right before they put in the core, for the material between the core and the water side of the reservoir, but it was not of the requisite thickness. There would be some uphill haul in the work at Pilarcitos or San Andres. From
the borrow pit below the wasteway on the left bank of the stream, 5197
you would have practically a downhill haul on nearly all of it. I do not know whether there was a large tree in what I call the borrow pit. Mr. Ebright showed us where this pit was, and as he was the man who was on the construction of the dam, I accepted his statement as correct. I took the material that is there in the construction of the dam. There are no waste pits around there to show that any of the material was thrown away. The height of the bank is such, and all the other conditions are such, that a steam shovel could have worked there advantageously. You would not allow a perfectly vertical bank to come along, you would have one of your pit men go up and cave down the bank; if it looked a little bit threatening, during the night time a man would loosen that overhanging bank with powder. Your shovel will break up the material 5198
in the pit in order that it may be loaded. If it goes in a lump, you have your devices on the dam for breaking and splitting it. There would be no difficulty about the pieces being broken up small enough to go into the dipper without trouble. You might have to bulldoze a little bit, but I have given you a crew there to take care of the droppings. My experience has been that that would handle it.

I have seen shovels operate along the Los Angeles aqueduct. I have seen them operate in Oakland, and in the City of Los Angeles. I have seen them digging cellars, and working on the Twin Peaks Tunnel here. I have seen them working on railroad cuts. I have seen a steam shovel working in a pit where they had to blast, in excavating the material for the Fernando Dam. The material there did not come out in large blocks. I did not notice any bulldozing there at all. I presume I have been on that work half a dozen
times. You would have to build roads from my pit to my dam, and 5199

after you got on the dam, you would roll and level as the dam went up. First, you deposit your loads in windrows, then you have a smoothing device to smooth the loads out; you can do that by harrowing; then you sprinkle it, roll it, and compact it. I consider that necessary. The specifications under which that dam was built calls for compacted material, and for the material to be rolled and specially placed. I figure four animals to a wagon when hauling dirt.

The puddle fill of the Dry Canyon Dam cost 73 cents a yard. I do not recollect how that was put in, but Mr. Mulholland informed me that it was very expensive work, and they had considerable trouble and difficulty with it. The Central Reservoir has no puddle
5200 trench. The core is above the surface of the ground. Here is a trench that is below the surface and filled with clay; above the surface the embankment is uniform right through the dam. The Pilarcitos Dam has a trench below the surface which is filled with puddle, and a core superimposed over this trench through the entire height of embankment. Referring to the Central Reservoir, there was a ditch dug through there below the surface, and this ditch was about 3 feet wide, and from 6 to 21 feet deep. It was filled with the clay. There was about 850 cubic yards of excavation in this cut-off wall. Your puddle core is material that you have in the center of the dam;
5201 if it is below the surface, it is the fill, but is in the puddle trench. If it is above the surface we call it the core. I cannot say that I have ever seen a puddle core put in, but I have had it explained to me by men that have done it. The number of cubic yards which my shovel would place in the dam per day would be 900. Referring to the Central Reservoir work: You have made a computation here that gives you 626 cubic yards, by dividing the total number of days upon which it was possible to work into the compacted yardage. The next one shows the total yardage removed, or placed in the fill,
5202 was 130,850, and that gives you 810 yards, according to this record.

I would put 900 yards in every day with my 1¼ yard dipper for this reason: If you will examine that record you will find that this shovel was engaged in building the trench through which the outlet tunnel was driven through the dam, and then it was idle. Then the shovel was put into the inside of the basin, and performs two functions; to get out material for the dam, and incidentally to trim up in a rough way the bowl of the reservoir, a condition nowhere comparable with a shovel working against the bank where the prime object is merely to get material. This shovel had a handicap; it could not go in beyond a certain depth, because that would necessitate filling up. I considered it, however, and it goes to strengthen me. It is supporting data, because that was a remarkably wet season, and they could have worked in that place, but they had very sticky and slippery clay, and quite a distance to travel, and the wagons had pretty nearly an uphill haul. You have material there that is

entirely different. The trouble there was that the teams were not 5203
there, and the steam shovel cannot work unless you have teams to get the material away. I noted it time after time when they didn't have a properly co-ordinated equipment. The work was done under the supervision of the engineer of the Peoples Water Co., Mr. Geo. Wilhelm, in 1910. I have no criticism of Mr. Wilhelm's way of doing it; I am relating the facts to you as I observed them.

I have an entirely different condition of affairs at Pilarcitos, but I have made some deduction of percentage for delays. I assume 5204
you will get that output with a shovel in a 9 hour day, and that I would get it every day when I am working; assuming the shovel to work 260 days a year, that is 5 days in a week, Sunday and one day off each week. I am assuming now that your shovel is going to work only 260 days in a year, and I am paying the crew through the year. If you have an interruption of 2 or 3 hours in the work when the teams are laid up, you would not pay your teams during that time. In figuring an animal, I figure that each animal works 5205
on only 260 days a year. If the teams are idle 2 or 3 hours, you would pay them; this is your production here, based on an average. After all your conditions every day you are working here, you are getting an output of 900 yards a day, basing it on the fact that each animal only works 5 days a week, which gives you 260 days a year. I am charging for the animals for the entire year. I charge his annual cost, and divide it by 260 days. The annual cost, outside San Francisco, is $1.19 per working day; inside of San Francisco it is $1.09. That is merely for the animal and harness, and does not include any wagon. I assumed the annual cost of food is $150.05 in San Francisco, and that outside of San Francisco it is $184.70 per animal. There would be 27 pounds of hay daily, which gives you 9,855 pounds for the year, at $15 a ton, that will equal $73.91. 18 pounds of grain gives you 6,570 pounds per year, at $24 a ton, which is $74.88; 40 gallons of water a day is 14,600 gallons a year, and charging 50 cents per thousand for that, it amounts to $7.30 for the water. That totals $160.05 per animal in San Francisco. For the food outside of San Francisco, and within 50 miles thereof, the hay is $18 a ton, or $88.70; the grain is $27 a ton, or $88.70 for the total 5206
grain. The water at the same price $7.30; total $184.70 per animal. I assume that the animal is to work 5 days per week, equal to 260 days per year. I am figuring on the animals, as there are always more animals than those actually at work. Then men are not laid up as often as the animals. This takes care of idle stock, and is based on the experience of contractors, and of the Southern Pacific Railroad. I took these matters on the best of authority. I got that from information, and from the records of others, and if you so term it, that is all I know about it, but I consider it is sufficient, and it the best.

Your annual charge is $40, 1/5 of the cost of the animal. Interest at 6% is $12; that gives you a fixed charge of $52. Your food is $160.05 in San Francisco. Shoeing for 12 months, at $2.50 a
5207 month, $30. Harness and repairs $11.50; stable expenses $30. That totals up $283.55; dividing this amount by 260 days, it gives you $1.09 as the cost of the animal for each working day. The 5 year period takes care of the life, because no animal will last you longer than 5 years. I figured on a 9 hour day on that work. I have timed the getting of a dipper full of material by the steam shovel and dumping it into the wagon many a time, but I do not give that much significance. It is the output I count on. The time consumed varies. You sometimes make three swings a minute with a dipper. I have seen it done in handling sand, but that is only in an individual case. In handling such material as you would have to handle down there, you would make swings enough to give you 100 yards in an hour.
5208 You would make one and a fraction swings a minute with a yard and half dipper. You would deliver into the dam on an average of 900 yards of material. I didn't go into the average load for every swing of the dipper. I am just giving you the output of the shovel, because that is what I am concerned with. I have not figured the percentage of the capacity of the dipper that would be represented by each of the dipper loads. The dipper, when filled, would
5209 hold 1½ yards of loose material. A dipper load of that material on the average would make a yard of material in the compacted dam. I didn't figure it that way. I am giving you the output. It is not impossible to deliver two dipperfuls to the wagon every minute. I have seen that done frequently. For whatever the computation is, I figure they will turn out 900 yards in 9 hours, which is 100 yards an hour when the shovel is in working order; you have your crew there that will make your repairs, and handle it that way. You are supposed
5210 to work these men about 6 days a week, and you are going to work your steam shovel 6 days a week, and every one of these six days it will average 100 yards per hour. You would have a 90 degree swing. I cannot tell an instance where a steam shovel, operating a 1¼ yard dipper, ever delivered 900 yards a day.

RE-DIRECT EXAMINATION BY MR. SEARLS.

Assuming that instead of getting a 300 day efficiency on my work for the year, I only got 260 days, it would not change my steam
5211 shovel figures but the fraction of a percent per year. It gives me 6.4 cents per yard for loading, and would change my total unit figure about .1 of a cent. I don't think it would change the 36 cents any on the embankment. I made a change in my estimated depreciation on the steam shovel when I made this calculation. I am simply taking the annual charge, and dividing it into 10 years. The life of a steam shovel is taken by shovel men to be 20 years. I figured

it at 5 years. I took my depreciation and covered it over 10 years, and paid my crew for the whole year. The net addition to my price from this recalculation would not be more than a cent.

RE-CROSS EXAMINATION BY MR. MCCUTCHEN.

I do not assume that I would have steady work every day of those five years for my steam shovel. I am taking it this way: The annual cost of the shovel, taking into consideration depreciation, interest and repairs, is $2,480; dividing that by 260 days is $9.54 per day. Then I employ the crew—the engineer, crane man and fireman, 5212
and I divide their total pay by 260 days. I allow the engineer $1800 a year salary, and pay his board at $273. That gives me an average cost of $58.14 per day, which I divide by 900, and that gives me 6.4 cents a yard for loading.

Witness: ALLEN HAZEN for Plaintiff. Hazen

DIRECT EXAMINATION BY MR. GREENE.

This is a schedule of the most important flume in the system.

Received and marked "Plaintiff's Exhibit 98s".

By small flume, I mean small in amount, and also in size. I did
not attempt to make a complete list of every little flume, but all the 5213
principal items are included. The smallest one I have here is just over $1,000. This was done over a year ago, and I think I took $1,000 as the limit. I think they are listed in accordance with the order in which they appear in the inventory. All the auxiliary structures are included in each case. I have figured the cost per lineal foot of flume, and then as a little further comparison to help in understanding the comparison, I figured them on the basis of per cubic foot of net space. That is, divided the cost per lineal foot by the number of square feet in the section.

Questioned by Mr. Dillman.

The detailed figures that make up these totals will appear in the schedule. This is only a summary. These figures may be divided broadly into two classes; the figures that relate to lumber in the lumber work, and the figures for excavation. As far as the lumber work is concerned, I went over that with Mr. Lawrence last year. I had had no experience building flumes, but Mr. Lawrence had built them. I went over the business with him, and cross-questioned him on it, and made sure to my own satisfaction that it was sound, and I took his figures. I think he has made further studies of it, and I don't know but what he has modified his figures somewhat. I took them on the basis of the figures he gave me, and with some analysis
and arrangement of them by myself. For the excavation, I started 5214
out by walking some of the flumes, and seeing what the work was,

and talking with Mr. Lawrence about it, and then making up my mind as to about what an average price for an excavation on this work would be. The excavation is in three classes: earth, soft rock or loose rock, and solid rock. Also there is an item for clearing. Mr. Lawrence had a record of the actual cost of excavating one of the last flumes that was built. This was not a complete record. He had the payrolls complete, but he did not have a complete record of the expenses that went with the payroll, and so we had to estimate those. I took that record, and went over with him the wages that were paid, and the wages that are current in recent years, and we multiplied the average by the prices that I thought were right from general experience with excavation, and so compared it with what the cost had been with an additional estimate for the materials which we didn't know about. We got in that way a comparison with the figures that seemed reasonable to me in the light of general experience for this particular work, with what it had actually cost, and with what it would cost as Mr. Lawrence figured it at current prices, which were more than the prices at the time the work was built.
5215 That comparison, as I made it, is set forth in my schedule on excavation.

That was the only test I was able to find from Mr. Lawrence's record, but it checked up my judgment on the cost of excavation. The statement of this was found on page 24a and b of Excavation Schedule. I used from $60 to $70 per acre for clearing, according as the brush seemed to be thicker or thinner. For earth excavation 40 cents per cubic yard; for loose rock $1, and for solid rock $2 per cubic yard. On the work that I referred to as Mr. Lawrence's computation, at the rates of wages that were current in 1913, applied to the old payrolls, amounts to $23,938. There was a partial list of materials $1,647, which obviously was not completed; there was a bill for explosives amounting to $585, but there was not reason to think that that was used entirely on this work, or that it was all the explosive that was used on this work, so the information as to the
5216 explosive is not final. I added, as a roughly approximate figure for materials 10%, amounting to $2,003.94. Adding that to Mr. Lawrence's calculation of the payroll makes $26,333. My allowance for that work, at the prices that I used, amounts to $24,058; in other words, less by quite a little than was computed by Mr. Lawrence by that method. I took that as a check of my judgment on what the unit prices for this excavation were, and that was the only check that I was able to get from the company's records. The other items which come to this flume schedule are very small auxiliary matters, and in the aggregate they are very little.

My lumber prices were taken from Mr. Lawrence, and modified as I thought they should be, and my excavation costs were my own, and based upon such data as I had. I made an estimate of the cost

of excavation in the first place, and checked it in this way. Mr. Lawrence's record does not give any basis for computing the three kinds of excavation and clearing, and in that respect, this is typical of a great deal of the old records. There is not any way you can find out from that record how much it cost per cubic yard to do the three classes. All we can do is to test the assumptions, and see if they correspond approximately with the data in the aggregate, and that is what I did. Mr. Lawrence does have the original cost, and it is a good deal less. This work was done in the late 90's when the rates 5217
of wages were a good deal lower.

SEVENTY-THIRD HEARING. DECEMBER 6, 1915.

Witnesses: Allen Hazen for Plaintiff.
N. Randall Ellis for Defendants.
A. P. Noyes for Defendants.
Geo. L. Dillman for Defendants.
W. B. Lawrence for Plaintiff.

DIRECT EXAMINATION BY MR. GREENE.

The flumes seem to be sufficient to perform the service. They 5219
represent a very economical method of transporting water. They are less permanent than some other structures. They are built cheaply, and in this climate the redwood of which they are built lasts very well. I do not think they are in use in the East in water systems. With the 5220
lumber we have, and with the climate in the East, I would not expect a flume to last over ten years. They last much longer out here because of the climate and of the wood.

The excavation work for the flume is quite a different class of work than that for laying pipe. It is mostly excavating on one side and throwing it over the bank, with no backfilling required. It is relatively easy work, although, no doubt, the difficulty of the work is increased somewhat by the fact that there are a great many roots to be contended with. The excavation is not ordinarily very deep, or done on a large enough scale so that a steam shovel could be used. I don't see any reason why excavation of that sort could be done by appreciably better methods than those that were used many years ago, when the flumes actually were constructed; I cannot think of any machinery that would be advantageous for facilitating the work. The method of applying present rates of wages to the payrolls of many years ago seems much more applicable to this class of work than to classes of work where the methods of doing the work are changed. The fact also that the work on the flumes is more or less skin or outside work is an element.

Questioned by Master.

In determining my excavation figures, I took the old payrolls,
5221 and applied the present rates of wages and hours as a check. I formed a judgment in the first place of what it would cost, which is based on all my experience doing that kind of work. I have never excavated for flumes, but have done work very similar in cutting a road along a sidehill, and am familiar with how the work is done. That is practically what it is, except that a road varies a little up and down. If there is a hard place, you go above it, or you go below it, and it does not hurt the road any. A flume has to go to grade, which makes it somewhat more difficult, and expensive an operation, relatively, than building a corresponding road.

Questioned by Mr. Searls.

I first made an estimate of the work without consulting Mr. Lawrence, and then talked it over with him, and adjusted my figures slightly.

Questioned by Master.

The excavation was so much for flumes uniformly, at the rate of 40 cents per cubic yard for earth, $1 per cubic yard for loose rock, and $2 per cubic yard for solid rock. The different characters of rock are all in the agreed schedules, and I followed those quantities. I used 50 cents per cubic yard in the first study, and then I found that the old Lawrence payrolls did not quite justify that, so that without trying to split it too closely, I dropped to 40 cents.

5222 Questioned by Mr. Searls.

The $1 per cubic yard for loose rock, and $2 per cubic yard for solid rock, were my original figures. I check it on the aggregate for the section of the three different kinds of material. There is no way from the old records by which you could check it, so that the ratio between the 40 cents, and the $1 and $2 is necessarily a matter of judgment. The deduction that I spoke of from the 50 cent item to the 40 cent item was my judgment after making the comparison, and thinking it over; it seemed to me that perhaps it would cost less than half as much for the earth as for the loose rock.

Ellis Witness: N. Randall Ellis for Defendants.

5223 DIRECT EXAMINATION BY MR. SEARLS.

The earth dam that I had the opportunity to watch rather closely was the Tabeaud Dam, in Amador County, now a part of the Pacific Gas & Electric Co.'s property, the major portion of which was constructed through the season of 1901. The work was done by contract, and the contractor was E. B. & A. L. Stone. The dam was built as a part of the Standard Electric Co.'s system originally, and I was superintendent of construction in the hydraulic department of that

company. Mr. Bassell was in charge of the construction of the dam, and his reports passed through my department, and I kept in close touch with the work. I was general superintendent of construction, and Mr. Bassell was under me. The dam was about 1¼ miles from our headquarters, and I was on it probably on an average of 2 or 3 times a week throughout all of its construction. I kept in close touch with the dam, and had to pass it both going and coming to get to any 5224
other portion of my work. I am familiar with the methods of operation in the construction of the dam. It was contracted for at a price of 40 cents a cubic yard, which included the building of the main embankment, and the placing of loose rock facing on the water surface, with such stripping and cutting as was necesary in carrying up the structure. The contractor was paid 40 cents a cubic yard, place measure, and had no extra allowance for anything in the line of clearing for the extra rock facing.

The dam was constructed largely with wagons and Fresnos. They were patent dump wagons, three yards capacity. The material was deposited on the dam, spread, harrowed, rolled and watered. It was built in layers. The first plans were to carry a puddle core completely through, but this was not carried out, as is explained in Mr. Bassell's report. They decided it would be more expeditious, and make just as strong a structure, by spreading the earth in comparatively thin layers, and thoroughly wetting and compacting it. The central portion of the dam was practically puddle—all the finer materials were deposited in there, and the dam was kept basin shaped all during its construction, the central portion receiving more water, the idea being to give that as much extra attention as possible. At the same time a light puddle face was carried up on the up-stream side of the dam, 5225
varying from about 10 feet at the bottom, to 3 or 4 feet at the top, which was also carried on with selected material, largely compacted by animals; that was a slight percentage of the dam. All the embankment was thoroughly rolled.

Questioned by Mr. McCutchen.

I think that abstracts from Mr. Bassell's report were incorporated in a book that he wrote, entitled "Earth Dams".

Referring to the specifications "The body of the dam shall be "built by layers not exceeding 6 inches in thickness for the first 60 "feet, or to contour 1220, and by layers not exceeding 8 inches "above that elevation. The dam must be maintained basin-shaped, "being at the foundation about 10 feet lower at the axis than at the "outer slopes." These specifications are attached to the E. B. & A. L. 5226
Stone contract. This work began at elevation 1160—40,000 yards had been placed in the bottom of the dam before the contract was let; that is, all preparations of dam foundation, bed-rock drainage, and the original covering of that, was done by the company. Such rock facing as is put on as is specified there was included in the price of rock fac-

ing, and was obtained largely from a tunnel dump. I notice this clause: "and it is understood that there is excepted from this con-"tract, and work to be done, the hand rock facing required for said "dam, which appears on the drawing hereto attached, above eleva-"tion 1220." The stone facing was not hand laid rip-rap; it was partially wasted rock, and rock that was hauled from a tunnel dump, and some small proportion of it quarried and spread on the up-stream face. There was a recommendation made that in the course of a year
5227 or two that the upper 20 feet, or in that neighborhood of that dam, be covered with hand-placed rip-rap. I do not know whether that has been done since or not.

"The body of the dam shall be built up by layers not exceeding "6 inches in thickness for the first 60 feet, or to contour 1220, and "by layers not exceeding 8 inches above that elevation. The dam must "be maintained basin-shaped, being at the foundation about 10 feet "lower at the axis than at the outer slopes.

"The up-stream half of the dam to be of selected material; the "lower half of the less choice material, but not waste material. By "waste material is meant all rock not passing through a ring 4 inches "in diameter, roots and vegetable humus. Waste material shall be "placed on the outer slope, as directed by the engineer, and shown in "the drawings.

"No single stone exceeding 5 pounds in weight will be allowed in "the earth fill. Layers of rocky material must alternate with layers "comparatively free from rock. Each and every layer shall be "thoroughly compacted by wetting, harrowing and rolling, prior to "putting on another layer of material. The finished layer, when dry, "shall also be wetted prior to spreading a layer on top. The contrac-"tor may take water from the Amador Canal by pipes and hose for "use of stock, or as required for the work. Sprinkling carts may also "be used so far as found satisfactory, and approved by the engineer. "Each and every 100 cubic yards of material shall have not less than "1 hours rolling, or its equivalent in compression affected by other "means. The amount of compression of each layer shall be such that "there shall be no quaking of the material on the passing of a loaded "car or wagon.

5228 "Puddling material shall contain about 30% of gravel, less than "two inches in diameter, and about 70% of clay. The inner face of "the dam will also be puddled, being 10 feet in depth or thickness, at "present bottom, and diminish to 4 feet at top of dam. The center "and inner face puddle wall shall be of choicest material available "to be thoroughly wetted and compacted by tramping and rolling, "either or both. After puddling the inner slope, a layer of small, "broken stone 2′x4′ in thickness will be placed upon it, which layer "shall again be backed by coarser rock waste as directed by the en-"gineer.

"Such facing of broken stone may be made by use of selected "material from the tunnel dump, while the waste proper may consist "of the remainder of the dump and other rock." The amount of compression that was obtained in the earth in the dam was treated in detail in Mr. Bassell's final report; an investigation was also made by Mr. Schuyler during the progress of construction. I have copies of both reports.

What those reports stated as to the character of construction, and the soundness of the structure, can best be covered, I think, by a summary from Mr. James B. Schuyler's report. "The construction of the 5229
"dam was being carried on in a manner entirely in accordance with "the best engineering practice. The materials are carefully selected, "properly manipulated, and compacted in a way to produce absolute "water-tightness in the body of the embankment, and a minimum "amount of future settlement. Finally, 'that no proper precautions " 'had been omitted to render the dam stable, water-tight, and secure. " 'That, from the general investigation of the plan, and the history " 'of the work, there was no cause for apprehension of the safety of " 'the dam when put into service, provided all proper precautions in " 'construction be observed henceforth. Some leakage may be ex- " 'pected, through the bed-rock around the dam, but this leakage " 'should be without danger to the stability of the structure.' " This leakage was taken care of prior to the construction of the dam by a system of drains which were subsequently concreted over. The dam was completed in 1901, and observations up to the early part of 1904 showed no particular increase in that bed-rock drainage. I am speaking now from my own experience during that time. I had a weir put on down below the drain pipe, and one of my attendants visited it every 2 or 3 days, and kept a check. There was no leakage at all on the dam proper. 5230

The length of the dam on the top was 636 feet. At the base it ranged from 50 to 100 feet. The height to the top of the ground was 120 feet. At the ends it was 117 feet. At the inner toe 100 feet, and at the outer toe 123 feet. The width at the top was 20 feet; at the base 620; slopes, 2½ on one; with rock-filled portion 3 on one. Portion built by company 40,000 yards; built by contractor 330,350 yards; total volume 370,000 yards; total weight 664,778 tons.

It was imperatively necessary that that dam be absolutely secure, as it was situated on a tributary of Jackson Creek, about 8 miles above the the town of Jackson, and a failure of the dam would have meant the total annihilation of the town of Jackson. Also it was an extremely high earthen structure, which was a reason for exercising considerable care, with about the same yardage as Pilarcitos, although it is higher.

I have visited the Pilarcitos and San Andres Dams recently, for the purpose of preparing an estimate on the cost of putting in em-

bankments. I made an examination as to borrow pit sources for ma-
5231 terial there. I was familiar, in a general way, with the discussion of the location of material as described by Mr. Schussler. I have not figured on all the items in the schedule, but simply figured the embankment, which is the main item, and on stripping. The building of a puddle wall was something that I did not feel I had sufficient familiarity with, the puddle work being done at Tabeaud being of a slightly different character than carrying on an individual puddle wall. From my general observation I felt that a price that would apply to one would apply to the other, and my figure on placing embankment is 50 cents a cubic yard in place. This is based on the wagon and scraper method. I estimated on that method on account of my familiarity with the same class of construction at Tabeaud; also in the individual elements that go into such a method, I have had quite a range of experience, that is on the costs and outputs of scrapers, hauling material, spreading and rolling.

5232 I figured on loading the dump wagons with Fresnos, and using wagons of practically 3 yards capacity. I figure it would cost to plow, loosen and place the earth in the wagons, 17¼ cents, and that the hauling would cost on an average 13¾ cents. Spreading, rolling and compacting, and the operations incident thereto, together with a road foreman, and men of that character, 11½ cents; general expense in the dam 2 cents; that gave me a total of 44½ cents, to which I added 7½% for profit on items where profit had not already been considered, and that gave me 47.87 cents. I figured that practically 19,000 yards of the structure would come out of the sidehill stripping, and was so accounted for; that there are 6,400 yards coming out of the trench that is so accounted for, and that the probable amount of bank material to be handled, as against the material in the structure, would be in excess of about 10%; that left me 337,000 yards of embankment, plus 10%, which would be 370,700. Deducting 25,500 yards already accounted for, would give me 345,000 yards, which is about 3% increase over the amount shown in the schedule as being in place. Taking that into account, it rounded my figures out to about 49.2 cents, and I called it 50 cents.

Questioned by Master.

That covers embankment, and I have a separate item for stripping. I figured that the stripping would split about 2/3 on the bottom, and 1/3 on the sides, and that the bottom stripping would cost practically 26 cents a yard, and my top stripping 50 cents; that would
5233 give an average of 35 cents per yard.

DIRECT EXAMINATION BY MR. SEARLS.

I did not attempt to make a direct comparison between the Tabeaud Dam costs and the costs that I have cited here; the Tabeaud Dam cost 40 cents a cubic yard—the contract price; what profit the con-

tractor made out of it I do not know. We were paying $2.25 for ten hours, and I presume he had the same schedule. On the Pilarcitos I figured my minimum labor as $2.50 for 9 hours.

The process of resolving a 10 hour $2 day on a straight basis of adding 20% for the deduction in hours to get to an 8 hour basis, is not a fair practice, I think, as the reduction is too drastic. I have worked men 10 hours, 9 hours, and 8 hours, and I feel this way: Taking the difference between a 10 hour day and an 8 hour day, that in working men, you will probably get the equivalent of an extra hour over working 8 hours, that if they work 9 hours at the same rate as 8 hours, they will accomplish practically the same amount as a man working 10 hours. Between the 9 hour day and the 10 hour day the difference 5234
in output is slight. If you take the resolution from a 10 hour day to an 8 hour day along the lines that I believe, it means that if the wage schedule remained the same, it would be an increase of 12½% resolving from 10 hours to 8 hours. Resolving from 10 hours to 9 hours along the same basis would probably mean an increase of about 6%. In working men the output is largely a question of the ability of the foreman and sub-foreman. If you are working them short, you can crowd them; if you are dragging, you can only hold them to about so much effort, otherwise you will run down your outfit.

We had a good working season at Tabeaud; the contractor started in April, and did not develop his outfit up to its limit until some time in June; when they were working full capacity, their output was in the neighborhood of about 2100 yards a day. Their contract called for the completion of the work either on the 1st or 15th of December, and they got out on the 15th of December with the work completed. They worked practically 8 months. There was some discussion during the construction as to whether or not putting in earth in that quantity was the best engineering practice; that is, whether there 5235
might not be subsequent settlement. We had a series of posts set along the Tabeaud Dam with reference to a bench mark, and levels were taken immediately upon the completion of the dam in 1901, and on a couple of occasions in 1902, and in 1903, and the settlement was almost infinitesimal compared to the height of the dam. The total amount of the settlement, was, I think, about 3 or 4 inches. A reading taken on December 18, 1901, on the center post of the dam, showed elevation 1259. On March 17, 1903, is showed 1258.61, or about .39 of a foot at the point of extreme settlement. That would be in the neighborhood of something under 5 inches, which we consider was very good in a structure 120 feet high.

I did not figure the cost of reproducing the Spring Valley dams by steam shovel work, because while I have had considerable steam shovel experience, I have not operated small shovels loading wagons. Also, I would want to have given more time to a study of the faces and so on, so as to know a little more about shovel movements. I feel,

in general, that the cost of placing the stuff with a shovel would have been somewhat less than scrapers; just how much less, I would not say.

5236 CROSS EXAMINATION BY MR. McCUTCHEN.

I think a steam shovel can dump more rapidly if it does not have to dump into a wagon than if it does. I have had lots of experience loading cars, but not wagon loading. I imagine it would not make as much progress with the wagons, because in loading a wagon you load an individual unit with a certain interval that is impossible to avoid in between. Loading a train of cars with a dinky service, that interval in the aggregate is smaller. You can load more material if you did not have to dump into wagons.

Altogether I made three trips down to Pilarcitos; one with Mr. Herman Schussler in 1903, and the other two trips, one was made in
5237 June or July of this year, the other a week or ten days ago. I would like to have gone into the steam shovel proposition, but I did not feel that with the crusory examination I have given it, that I was justified in estimating on steam shovel work. I felt it would have been necessary to have devoted very much more time to an examination of the locality so as to have enabled me to determine whether a steam shovel could be profitably used or not. On the first trip to Pilarcitos, I was there possibly an hour and a half, and possibly the same length of time, or a little more, on the second trip. There were borrow pits pointed out to me as having been borrow pits, but that did not influence my figures. I figured that the material would have to come from within a range of 1,000 or 1,200 foot wagon haul, and also that
5238 part of the material would naturally come from inside the reservoir.

I would use wagons of 3 yards of loose material capacity, which would represent in the dam about 2.1 yards. I figured that a 3 yard wagon of loose material is equivalent to about 2¼ yards of that stuff, bank measurement, and that would probably represent 110%, as it was 10% swell of the stuff in the dam; that would be somewhere in the neighborhood of, say, 2.2. The shrinkage in Tabeaud Dam was heavy. Tests taken after it had been compacted ranged in weight from 130 to 133 pounds to the cubic foot of material. Material from the test pits ranged, I think, on an average of 116 to 118 pounds to the cubic foot. The material in the dam represented about 85% I should say of the material in place. 38% compression is correct from the wagon to the dam, but not from the pit to the dam. At Tabeaud a 3 yard wagon represented in the dam I think 1.85 yards. In making
5239 my figures here, I have not figured on the same compression as at Tabeaud; at Tabeaud the greater portion of the core was puddled. At this dam, you have a puddle core, and there is not the necessity for that care and attention in compacting the reinforcing embankments as there was at Tabeaud. Tabeaud was a puddle structure.

Questioned by Master.

I did not assume in this reconstruction figure that I would spread my material in layers and roll it off as strongly as at Tabeaud. I figured with this material it probably spreads in the neighborhood of 12 inch layers so far as the main embankment goes, and that would be sufficient. Tabeaud was put on in 6 and 8 inch layers. The central part of Tabeaud was practically made of puddle.

CROSS EXAMINATION BY MR. MCCUTCHEN.

I have seen rolling done in 12 inch layers on embankments in dams in Twin Lakes, Lower Blue Lake, Upper Blue Lake. We would go over that with animals, and it is 12 inches deep. That did not contain much clay, but was more sandy in character, but if you had a 5240
material of a clayey nature it could be spread easily I think in from 10 to 12 inch layers and compacted. I would have 4 animals to the vehicle. The animals coming in on the dam, come in on the portion that has been rolled, and as they move along, they drop their stuff in rows. That is the way Tabeaud was constructed. Then a grader comes along and spreads it out, and is followed by a sprinkler wagon. That is followed by a steam roller, rolling it. A steam roller would have no difficulty in getting over 12 inches of material of that kind. We used a steam roller on broken sub-grades in the South, where the loose stuff was considerably deeper than that.

I read Mr. Schussler's testimony, and he said his carts or wagons 5241
hauled 35 feet, and that represented 27 feet compressed in the dam. That is a lighter compression than at Tabeaud. That was in his 1904 testimony. I think you would have fully as homogenous a mass as is at Pilarcitos for that reason. I would not expect considerable settlement in the dam which I would construct. I do not think there could be any more settlement than has existed in Pilarcitos. There might be more settlement than there was at Tabeaud, which settled about 4 or 5 inches in 3 years in a height of 120 feet. I would expect that that settlement would be possibly a foot and a half at Pilarcitos. I do not know that the core wall center would be a foot and a half too; I do not know that the core wall was carried completely flush with the top of the dam. A puddle core wall would possibly not have that much settlement. It is not possible that my puddle wall would stand a foot or 18 inches above the top of the embankment 2 or 3 years after the structure was finished; the dam would be crowned, undoubtedly, or 5242
raised on up. I could not tell, without looking at the plans of Pilarcitos, but I do not think that the puddle wall was carried right flush with the ultimate crest of the dam. I do not know just the action of the core wall there, but I assumed that the compression stated by Mr. Schussler represented the facts, and the dam as it stands today looks to be an indication of that. I do not know that it would be particularly objectionable to permit the two sides of the dam to settle for 2

or 3 years, and have the core wall remain in its original position. I think any settlement of that kind has undoubtedly taken place at Pilarcitos, and I presume the Pilarcitos is an impact structure.

I would carry my embankment up with the building of the core wall. The core wall I presumed to be reproduced as good core wall was. I understand it was largely hand tamped, and wet clay puddled over it; it was more of hand work. That was one reason I didn't figure on it as an individual item. I never heard directly whether the
5243 contractor on the Tabeaud Dam made money or lost money, but I understood that he did not lose money.

The borrow pits at Tabeaud were largely inside the reservoir basin; I think about 80% of the borrow from Tabeaud made available storage in the reservoir; in other words, it was taken out below the ultimate high-water mark of the fill of the reservoir. It was trapped into wagons. There were several classes of material, largely clay in character. The analysis showed, I think, that about 30% of the material to 35% in the structure was of small rock and fine sand, and stuff of that character. The borrow pits were opened by the contractor. The company did very little work at Tabeaud; they confined their attention more to putting in this bed-rock drainage system, and making the first filling to get that covered up, and I think that largely was run
5244 in from wheelers at adjacent points.

The total yardage in the dam was 370,350 yards. At the time the contractor began work, the embankment had been brought to a height in a neighborhood of 25 feet.

Mr. Searls: I have a copy of the specifications on the Pilarcitos Dam, showing that 12 inch layers were used there as a matetr of requirement.

Mr. Hazen: I have never known of 12 inch layers being used; I should not suppose it could be with the material at Pilarcitos. We have to reduce the layers repeatedly in this kind of work, as the material is pushed ahead by the rollers until it blocks if it is too deep, and from the standpoint of getting the work done, it has been necessary to use pretty fairly thin layers.

5245 Mr. Ellis: The portion of the embankment constructed by the company before the contract was let was probably the most expensive part of the embankment work. It was in a small hole, and the material was not difficult to get. In that connection, I will say, it is only a matter of quotation from a man who is dead, Mr. Bassell, the puddling over the bed-rock drainage system was on an average 55 cents, but the company was not at all equipped to do the work; it started work in a haphazard way, and that is the reason it contracted it.

I do not know the complete cost on Tabeaud. The accounts, as kept in the San Francisco offices, were so mixed up that it is difficult to get anything on it. They were merged in one; the dam, the tunnel, etc. The contractor did not incur any expense in looking after

water. There was very little water in the canyon, but there was some flowing from a tunnel that was being driven, and they ran a little steam pump in the sump of the dam constantly. There was no water to amount to anything above the dam to be taken care of 5246
during construction. The whole watershed was very small; its area was but 2 square miles. All around one side of the Tabeaud Reservoir ran the Amador Canal, and it ran not a great distance above the high-water level at Tabeaud, and the drainage coming on in that neighborhood, and through those sidehills, and so on, went into the canal and was carried off. Water was supplied to the contractor without charge. I made an allowance in my estimate of 1 cent a yard 5247
for water. I do not think you would have more water to take care of and make allowance for in the reproduced structures at Pilarcitos and San Andres as against Tabeaud, but I presume that if there was much, or a heavy stream flow, the water would be collected, and probably used on the works. At Tabeaud, part of the water, as far as drainage water is concerned, was also connected on up with a pipe that went into the bottom of this sump, which on the completion of the dam was sealed. That was laid by the company, and had to be done by someone before the embankment could be built. The company had men working there off and on before the contract was let to E. B. & A. L. Stone. I do not know the maximum force that was 5248
ever at Tabeaud, but the camp when I took hold of the work in October, 1900, was about a 60 or 70 men camp, including the different tunnel crews. The roads to the borrow pits had not been opened before the contractor took hold of the work. The 40,000 cubic yards was taken out from the nearest places they could get it to the dam. There was the old road through the reservoir, which was in such a shape that the contractor's first move was to re-grade it. I am speaking of inside the property. Of course, the county road approached the property. This old road that was inside the property did not amount to anything, and in half a day he had the thing put in shape with teams and scrapers. The contractor's camp was not established there before the contractor came. He put up his own 5249
camp. The contractor was on the job 8 months to a day. That was not a year of low prices for labor. I was working about 1300 men, and it was a season of big demand for labor. That summer there was a big strike of gold up North, and late in the fall we had a hard time to hold men for awhile.

That was not particularly easy material to work; it was clay with an admixture of sand, and from what I saw around Pilarcitos, I think the materials are somewhat the same, and possibly Pilarcitos a little easier. I did not make any examination that would enable me to form any opinion about that, except such evidence as I could see of material along road cuts, and at a couple of places where it was open. The material was fairly deep at Tabeaud where the

borrow pits were. There were numerous borrow pits opened there, but how many I do not know. They would ordinarily run 4 traps simultaneously; I do not recall the number of times that they
5250 changed traps, but they had this trouble; the specifications were rather rigid, and the engineer that we had stationed at the dam insisted that they be carried out to the letter of the law. On segregation of material, the contractor attempted to use a shovel, but the shovel would mix the material so that it would not come up to Mr. Bassell's idea of what it ought to be, and so the contractor did not use the shovel much, it took too much time moving around. Bassell insisted that clays of different characters, and other material containing various degrees of rock and so on, should be selected and placed in their respective parts of the dam. Using this shovel, there was quite a number of kinds of stuff around Tabeaud, and they could not segregate a wagonload very well, because it was pocketed in places with little rock pockets, and it was pocketed with a sort of ashy stuff that had to be rejected. A segregation of those materials was what was insisted on; the specifications were drawn that way, and we made the contractor live up to the specifications.

5251 I imagine that at Pilarcitos you would be required to change from place to place to possibly the same degree as we did at Tabeaud. I did not anticipate that there would be a good deal of skin work at Pilarcitos and San Andres. At Tabeaud our borrow pits would hold a fair amount of material, and were of varying size. I imagine that the same condition would apply at Pilarcitos. The borrow pits would range from 8 to 10 feet deep, and we confined ourselves as much as possible to the submerged area of the reservoir in order to get capacities in there. They concentrated the force in there so as to make it larger. I did not estimate that all of the pits at Pilarcitos would be 8 or 10 feet deep. I estimated from conditions on down through there, and what I had read of Pilarcitos, that the conditions
5252 would be pretty much the same as at Tabeaud. The borrow pits were spotted largely to avoid rock at Tabeaud. I know on the dam we rejected anything over 4 inches in diameter. The small stuff that happened to be mixed up with the native material went on in as making a clay concrete. I should say possibly where the borrow pits went in there was 5% of rock that would bother. They did not use any powder in the borrow pits to amount to anything, but there was powder used which was largely in quarrying out some rock for the slopes.

I would not say the conditions at Tabeaud, so far as borrowing material were concerned, were ideal. If we could have prescribed an ideal condition, we would have had the clay less scattered. The length of the Tabeaud Dam is 636 feet. The valley was a flat little valley, and the gorge at the bottom, where the dam was placed, I
5253 think, was about 50 feet. I suppose an extreme width for the valley

at its widest place would be 3,000 feet; something in that neighborhood. In the bottom it was flat, and there was not much doubt about the ability of the contractor to get ample material there.

Mr. Searls: Mr. Calvin Brown, Superintendent of the Spring Valley Water Works, on June 17, 1865, reported with respect to the Pilarcitos pipe: "The site was chosen from the favorable character "of the topography, the narrowness of the valley at this point, the "convenience and abundance, and excellent quality of the materials, "of which it had been decided to build the work, and the large space "it would enclose for the proposed reservoir."

Mr. Ellis: I took 7½% as the contractor's profit, having allowed him stock rent; I figured the stock at $1 a head, and with the 5254
wagons I figured $1.25 a head; the $1 a head included the cost of rental of stock. If a man is working his own stock, he would put in stock at a stock rental basis, the same as he would rent them to an outside person, and then he would charge 7½% in lieu of the 10%. On railroad work we are allowed 10% on our force, which is called force schedule, and which is stock at so much a day. You are not allowed, in railroad work, your camp overhead, supervision, or anything of that kind. If you have the scrapers, they pay you for scrapers and drivers and stock, and allow you 10% to take care of your field overhead, and whatever profit you figure on. I figured that stock on a force schedule as a matter of convenience, and as easy to compare with other figures; figuring the stock on the force schedule, and allowing 7½% over it all, it would probably amount to the same thing as if they got ten or twelve percent over all. I don't know exactly.

I have known some embankment work that cost more than this Tabeaud work, and some that cost less, which was not similar though. We did work on raising the banks at Twin Lakes that cost us 32 cents. The material was handled with long hauls of wheelers, but it was sandy in character, and very easy material to borrow. I had about the same condition as to cost at Upper Blue Lakes; it was cheaper than at Tabeaud, and there was not the care put on the bunching of the material; they were comparatively low dams. There 5255
was some filling on a dam at Lower Blue Lake where the expense was considerably greater, but the conditions were not at all comparable; it was repair work on a ruptured dam where there had been an old earth dam—it was built with a rubble masonry core wall, and the core wall backed by two banks of earth, and they in turn reinforced by two side walls; the reason of that construction was that earth was extremely scarce in that country, and most of it had been taken out in the building of the original dam. We had to go a great distance for earth, and the earth which went in was not comparable with building a full dam; this was built in between the core wall and the retaining wall. From my personal experience I

cannot state any dams that came under my own charge where the cost exceeded the Tabeaud cost. All of my experience, or nearly all of it, with reference to dam work, comes from my association with the construction of the Tabeaud Dam. My figures on this work are
5256 not directly based on my experience with reference to Tabeaud, except to a certain extent. I figure that this proposition resolves itself into three practical operations, as the main operations, the loading in the wagons, the hauling and taking care of it on the dam. The trapping is purely a plowing and Fresno affair. As to plowing and Fresno work, I have been in contact with and done plowing and Fresno work. We have done lots of Fresno work on railroads. I have done Fresno work on track work; I have done Fresno work on the Standard Electric, and have had a wide experience with Fresno work, and my figure on the Fresnos and plowing is based largely on that experience. I had experience with Fresno work down South in connection with the highway work.

In connection with hauling, I have had considerable hauling done at different times, and watched the operations of teams on hauling material. It is a matter that comes up a great deal, and is of considerable consequence. On rolling, spreading, and so on, the most of that sort of work is based on road work, but when it came to that element of the computation, I figured the maximum equipment that took care of this in the Tabeaud Dam, and figured accordingly. In other words, on the road grading, rolling, harrowing, and so on, I figured that you could handle it with the same outfit as was used at Tabeaud for that item of the operation. The Tabeaud
5257 rolling was concentrated, and called for an hour's rolling per 100 yards, and I figured on this dam that they would probably use 2 rollers, and charge them up against the dam; I mean, if they were in operation, they would be rolling, and if they were not, you would have to pay for them anyhow. I figured a cent for water in this item of 11½ cents.

If men are working 10 hours, and you cut them down to an 8 hour day, the direct reduction would be 1/5th, but I do not figure
5258 that the reduction is 1/5th at all. I do not know what the experience of mine owners is now as compared with formerly when they worked a 10 hour day. I do not know what the experience is in lumber mills in this state where there has been a reduction in hours. I am citing from my experience, and from the discussions of the matter I have had with numerous men, such as contractors, and so on, and refers largely to unskilled labor, skinners and muckers. It is impossible for a man to determine a definite rule. The only thing you can pass on is having had bunches of men who worked for you 10 hours whom you have observed, and men working for 9 hours, and 8 hours, and sizing them up man for man, and drawing your own conclusions that way. I have had that experience, having had

men work 8, 9 and 10 hours. I heard Mr. Dorward say that he allowed a difference of 20% between an 8 hour day and a 10 hour day, but he was talking of shop practice; there is the biggest difference in the world between skilled mechanics and unskilled labor. I do not think that the men around the contracting camp on ordinary construction forces are effective in the same way that the more skilled labor is. I think it is more true of the skilled labor that they will do only 80% of the work in 8 hours than they will do in 10 hours than it is of the unskilled labor. You can drive unskilled labor, and ordinarily a foreman who has a gang knows about what he can get out of that gang, and he gets it out of them. It is the same as a person in ordinary work. I have noticed it myself, he can't keep up a 10 hour effort at what his 8 hour effort was. I have had occasion to watch that. 5259

If the contractor at Tabeaud lost money, my views would still be the same with reference to the cost of constructing Pilarcitos and San Andres.

Witness: A. P. Noyes for Defendant. Noyes

DIRECT EXAMINATION BY MR. SEARLS. 5260

I reside in San Francisco, am a civil engineer, and have been engaged in that occupation about 20 years. In 1907 and 1908 I was City Engineer of the City of Vallejo, and during that time we constructed an earthen dam, designated as the Wild Horse Valley Reservoir No. 2. I designed and prepared the specifications for that dam, and it was built under my direction by contract. Mr. Lewis Moring, of Stockton, was the contractor. The dam was constructed on a watershed lying about 5 miles east of the City of Napa. It is over the range of mountains that borders Napa Valley on the east. There is an elevated plateau there, with a drainage area of about 6 square miles. That contracts at the point where the dam is located to a narrow, rocky gorge, and at that point we built this dam, which was an earthen structure, approximately 92 feet above the water of the creek at the crest of the dam. It had a slope of 2½ to 1 on the water side, and 3 to 1 on the lower side. The length of the crest was 580 feet; the width at the base 30 feet. The yardage was 117,000 and some odd; we allowed the contractor that on his final estimate. This was not a core wall dam. The specifications required that the upper half of the dam should be constructed of selected material, and the lower half of materials that might be inferior to the selected material. It was constructed of material of a gravelly clay deposit secured at the bed of the reservoir. This was hauled on the dam in dump wagons, and trapped from the wagon, and then a road grader drawn over the pile, and the pile spread out to a depth of 5 or 6 inches. We had a very desirable material to construct the dam from, 5261 5261½ 5262

and I specified that the whole front half of the dam toward the water should be constructed of this gravelly clay material, and compacted in 5 or 6 inch layers. It was compacted by the passage of the wagons over the top of the dam, and arranged to carry the entire strip right across the top of the dam, and then put the traffic over that strip, after being first leveled off and sprinkled. We did
5263 not use a steam shovel at all. The dirt was secured in this way: They had 3 New Era grading machines, and kept 2 in operation all the time, and one in reserve.

The borrow pits had to be stripped. It took 5 months of actual embankment work, commencing in August of 1908, and discontinued during the winter, and completed in April or May, 1909.

Questioned by Mr. McCutchen.

The work was done under contract.

DIRECT EXAMINATION BY MR. SEARLS.

I will read section 26 of the specifications: "It is not intended "to construct a separate puddle wall or core, so called, in the center "of the dam, but rather to make the whole upper half of the dam "one mass of selected puddle material, adjoining which, in the outer "slope of the dam, the less desirable material may be put.

" The latter shall not, however, differ from the rest of the dam "material in the care or manner in which it is worked into the dam.

"When put into the dam, all material shall be moist, uniformly
5264 "kneaded free from roots, and any matter which can be recognized "upon inspection as being of vegetable origin; it shall be free from "rocks and cobbles, and from all gravel larger than a hen's egg in "size.

" Whether brought to the dam in a dry state and then moistened, "or moistened before being carried on to the dam, the material must "be worked into the dam in a perfectly moist state, and be thor- "oughly consolidated by suitable trampling by animals or rolling, "by harrowing, and by the passage of the wheels of vehicles, in such "a manner as to join the whole mass into one compact volume, such "as is essential to all well constructed dam work.

" All material shall be deposited in thin, horizontal layers, not "to exceed 4 or 5 inches in thickness, and the whole surface of the "work kept as nearly at a uniform level as circumstances will per- "mit.

" If a roller is used upon the dam to compact the layers, no new "material shall be laid upon a rolled surface until such rolled sur- "face shall have been roughened by means of a harrow, or some "other suitable device for roughening the surface, and no fresh "layer of material will be added unless the layer underneath the "same is thoroughly moistened, and in a fit state to incorporate "with it.

"Whenever earth work and rock or masonry adjoin, especial "care shall be taken by thorough tamping and puddling of the "earthwork to produce water-tight contact.

"All work shall be laid agreeably to the direction of the engi- "neer, or his inspector, and it shall be discretionary with said engi- "neer to require a change in the method of building the embank- "ment, or a change in the appliances used for building the embank- 5265
"ment, whenever it may appear that the methods followed, and the "appliances used are not such as are in his opinion, best suited to "produce work of the most substantial character.

"If at any time a hole be dug in any newly laid work, and dry "material be found under the surface, or any imperfectly joined "layers of material be visible, such work shall be removed and shall "be replaced by properly constructed embankment at the con- "tractor's expense, and the engineer may call for the immediate "discharge of employment of any laborer or foreman responsible for "such defective work." That clause of the specification was made use of. After 3 years there was a settlement of about 14 inches in the center of the dam, but there have been no leaks, whatever, and it is perfectly tight. It was important from the standpoint of water supply to the City of Vallejo that the dam should be perfectly tight.

I have prepared a table showing the contract price, and the 5266
unit price, on each of the elements of construction, and also the cost to the contractor. The contract price was taken from the contractor's bid, and the unit cost to the contractor was taken from the cost account kept by the superintendent of construction for the City of Vallejo.

Questioned by Mr. McCutchen.

Those units were verified by being submitted to the contractor, and receiving his certificate.

DIRECT EXAMINATION BY MR. SEARLS.

The table which you have handed me is a compilation, or rather 5267
recapitulation of the force and material account of Wild Horse No. 2. That compilation was made by me. The sheet entitled "Recapitulation of force and material account" was made by my superintendent of construction, and signed by me as City Engineer, in a report to the City Council. It was made under my direction. The third sheet entitled "Cost report, 1908" is an analysis of the progress of work during the month of November, 1908.

Introduced and received as "Defendants' Exhibit 106, 106a, and 106b."

Referring to sheet "106"; the figures shown thereon include the item of $3,000 which the contractor has certified on sheet 106a as being his overhead, depreciation, and field equipment charge. The total money received by the contractor was $59,982.63, which in-

cludes some extra work. The total cost is shown on sheet 106 as $55,231.85. The contractor on that basis made a profit of about 8½%. This shows that the City paid 35 cents per cubic yard for the
5268 earth embankment, and the cost to the contractor was 30.63 cents. In the specifications it is provided that the price bid by the contractor per cubic yard for the embankment in place should include stripping his borrow pits, building roads, and so on. It included the construction of concrete gutters on the back slope of the dam to carry off the rain-water, and to prevent it from washing out the earth embankment. It included the gravelling of the crest of the dam to a depth of 6 inches to provide a roadway over the top of the dam. We used stone blocks to a depth of 10 inches, on a bed of 4 inches of gravel. The stone was laid in horizontal courses, and was secured from stone fences in the vicinity, and some stone taken from the removal of stone excavations. The item of rock excavation, on
5269 which a price of $1.25 per cubic yard was bid is a volcanic rock, and required considerable powder in handling it. The contract price for clearing brush was $25 per acre, and the contractor lost money, as it cost him $30.78. There was a heavy growth of manzanita brush on a rocky bed-rock formation that comprised the gorge, and above the gorge there was considerable scrub oak; along the bed of the creek there was some willow brush. There was some difficulty in pulling out the stumps of the oak trees; they were 12 or 14 inches in diameter. This contract includes grubbing as well. The contractor sold 128 cords of oak wood that he saved from the clearing, and he also stored up sufficient wood for his own use for 5 or 6 months. That is subtracted before the unit price is arrived at here. He is given credit for the wood at the price at which he sold it.

When the contractor took the contract, he agreed to complete the work by December 1, 1908, as it was very important that he get
5270 the reservoir into commission. At that time the rains commenced, and he had about 80% of his dam completed; on the first of January he was compelled to suspend all work on account of a cloudburst that flooded out his borrow pits, and drowned out his camp. No more active work was done on the construction of the dam until April. He was compelled to keep a large force of men there to protect his goods. For about 6 weeks there was a stream of water passing over the top of this earthen dam, and he protected it by covering it with canvas. By keeping a force of men constantly watching the dam, they were able to carry the flood waters over until they could be controlled by the pipe that was under the dam. That took about 6 weeks.

About 80% of the material came from a borrow pit that was about 2100 feet from the dam. They lost very little of the material of the dam when the water broke over during the winter-time. I will read the specifications on rip-rap: "Section 27. Rip-rap. All

"portions of the dam slope next to the water, and which may be 5271
"exposed to the cutting action of waves, will be faced with rip-rap.
"This protection will consist of a paving of the slope with stone of
"suitable dimension, carefully laid in horizontal layers, roughly
"coursed. The stones must have good, sharpe, and square corners;
"must show faces of not less than 10 inches in height by at least
"16 inches in height, and must form a paving nowhere less than 10
"inches in thickness. Between the paving and embankment slope a
"layer of gravel or broken rock 4 inches thick will be laid to drain
"off the water dashing through interstices in the rock."

The common labor was on the basis of $2 and 10 hours. There was about 850 yards of gravel hauled there for placing under the rip-rap. I had to use gravel in some other places; water would come 5272
down the hillside and run over the rip-rap and channel it out, and the rip-rap dropped in. I provided in this case that there should be a bed of gravel under it in order to drain any water that came in under the dam from above.

Mr. Lawrence: I would not like to state from memory, but I think the rip-rap at Pilarcitos is from 12 to 14 inches thick.

Mr. Metcalf: That would mean that the rocks are that long when set up on end.

Mr. Noyes: There was 2,125 cubic yards of rip-rap rock used, and the haul was something like 1700 feet. The gravel came from the borrow pit that was opened up in the bed of the lake, with an average haul of 2100 feet. The dam was completed in April and 5273
May of 1909, but during the winter we had to go for our gravel to a new source, the old borrow pit being under water; we went for gravel down to Valley Green Creek. That was a maximum haul of about 4,000 feet. For the earth embankment we got dirt above the high-water line at a distance of about 1600 feet, but it was much more expensive to get it, for the reason that it was a narrow strip that we had to pick it up from. The cost of the rip-rap is 3.9 cents per cubic foot.

CROSS EXAMINATION BY MR. McCUTCHEN.

The New Era grader is a road-making grading machine which is 5274
composed of a plow and a draper; the plowshare throwing the dirt on to the draper, and the draper taking it up and dropping it off into a wagon. It can be dragged by a caterpillar engine, and also by horses. I have never known of its being used in dam construction before being used in the Vallejo Dam construction. There were 12 to 16 horses used on these graders at Vallejo, strung out 4 abreast. It requires considerable room to turn it, but it does not require a very large borrow pit to use it; if you have several acres you can work very economically. There were about 30 acres in the borrow pit at Vallejo, but I think the outside of the excavation all the way

around would cover about 10 acres. There was just the one borrow pit for the first 3 months of construction; in the spring they went to another place where there was a long narrow strip, and they used the same New Era graders there.

5275 The work began in August, 1908, and the borrow pit was on the field above the dam, distant 2100 feet from the work. About 80% of the material came from this borrow pit, and the remainder came from a strip along the edge of the lake created by the winter's rain. I have never known of the use of New Era graders in dam construction since that time, but I do not think that it was because the conditions at Vallejo were peculiarly favorable; they could be used with economy on any proposition where there is dirt to be put into wagons, and room enough to turn one of those wagons around. I have seen a great many of these graders in use by contractors and other people, and I have seen dams where I think they could have

5276 been used profitably. It is possible they were not used because the contractor did not have that sort of equipment. I cannot recall any place at the present time where the New Era grader could have been used to advantage. I could not say of how many dams I know where the borrow pits were 10 acres in area. If there were boulders in the country where you were operating, you could not use the New Era grader to as great advantage as where you have clear soil; you must

5277 have a soil you can plow with 10 or 12 horses. It has to be a suitable soil, but I do not say that an alluvial or a prairie soil is the only soil you can use. It could be successfully used in sand, or any level formation that could be plowed. You could not use it in any soil that could not be plowed, but some rocks can be successfully handled.

5278 I would make an examination of the site in advance of the commencement of my work, and if I thought I could work the machine to advantage, I would use it.

Mr. Dillman: I can show you several miles of small dams that were made with a New Era grader. That was in the Oakdale Irrigation District, and the material was rock. It was on the San Joaquin plains, and the rock consisted of clay shales, soft sandstone, through

5279 which you could run a plow such as they put on a New Era grader. I have seen plows go right through what is classified as solid rock, but I do not say that a New Era grader can be used in solid rock. I have seen solid rock plowed, but I would not handle a New Era grader on that work, because you could use a different instrument to better advantage. It costs $3,000 or $4,000, and I have not used it

5280 at Pilarcitos, because the lay of the land is not good for it; it is too steep. The country is too confined. There is plenty of room there to use, but the slopes are not proper for it. I do not think the conditions there for the use of a New Era grader were or are as favorable as for its use in Vallejo. I think you could plow the material you find at Pilarcitos with one; that is, part of it, and also

part of San Andres, in the borrow pits. The soil shows it above the 5281
dam and considerably below the dam, and I count on getting the material, most of it, on one side of the dam at San Andres and into the sidehill. There should have been borrow pits under the rocks above the dam, but I do not know that there were. The borrow pits that I can see, are opened up in the bottom below the dam, both at San Andres and Pilarcitos, that you could use a New Era grader in. You could use a plow in the material below the dam at San Andres where the borrow pits were, but I presume you would encounter rocks that could not be plowed. I didn't propose to load my wagons with a New Era grader, because I could use a steam shovel on all of it. It is a cheaper method of 5282
handling dirt by the New Era grader when you can use it, but I figured on the more expensive method. In some cases it is 100% less expensive, and in other cases it is very much cheaper.

I draw a distinction between compacted soils and rock when I say that hard material is material that is hard to penetrate approaching rock. I mean all soft rock you can plow with a New Era 5283
grader; all the clay shales that I have encountered in work on this coast. I mean to any depth you want to go, and I recognize a distinction between shales and the material in which you find boulders. You could use the New Era grader in material where you find boulders, as you could work around boulders, but therein you add up expense until you get such material, that you had best use some other method.

Mr. Noyes: At the present time we are engaged in the San 5284
Joaquin Valley in the construction of check dams and levees for the swamp irrigation of land, and we are utilizing New Era graders in that work, because they are a very economical tool to handle the dirt with. In this case we are just throwing the dirt up on an embankment. This work is down near the Wasco Road in Kern County, about 30 miles north of Buena Vista Lake, up near Lake Tulare. Wasco is a station on the Santa Fe about 20 miles northwest of Bakersfield, in the Delta of Kern River. The soil there is alluvial, and we used these machines almost exclusively in the construction of irrigating and drainage ditches up to a certain size construction of base levees. You do not require 10 acres to handle one of these machines, but if you have 10 acres you can make a bigger circle and 5285
handle it easier. In the vicinity of the two dams which you are speaking of here it seems that there is plenty of room above those structures that would be all right if the soil condition was satisfactory, but I know nothing about that. I would want to make an examination in order to be able to express an opinion of value on that matter.

The wages paid to laborers on this work is $2 a day, and he owns his own stock. That was a time of comparatively cheap con-

5286 struction. In 1894, 1895 and 1896 there was a period when construction was very cheap, and that condition was general throughout the state. This was Wild Horse Dam No. 2, and there was a Wild Horse Dam No. 1, built in 1894 by the City of Vallejo; it is situated about a mile further down this same watershed, below the location of this structure.

RE-DIRECT EXAMINATION BY MR. SEARLS.

If you have to trap the dirt, the cost of placing the earth in wagons is an item of expense in the constructing of an embankment. It is not an item of expense with the New Era grader, because whether you trap it in a wagon, or put it on an embankment, the cost of operating the grader is just the same. It goes right along without stopping, as it has to keep moving in order to handle the
5287 dirt. My experience with steam shovel work was at the Mare Island Navy Yard. In that case the contractor loaded the dirt into cars on a track; it was not in wagons, although I do not imagine there is much difference in the expense whether you use a wagon or cars. I believe that a steam shovel could have been used on that same work, and I base that belief on the fact that this deposit of material is quite deep, and there was a creek down through it that showed a bank of about 8 to 10 feet which they would have to work from. With that depth of bank, a steam shovel could be operated to advantage. This man had the New Era graders, and brought them up there and operated them successfully.

Dillman Witness: GEO. L. DILLMAN for Defendants.

DIRECT EXAMINATION BY MR. SEARLS.

5288 If the contractor had done it with steam shovels, it might have added 5 cents a yard to the cost of loading the wagons, which is the only cost that would have been increased.

CROSS EXAMINATION BY MR. MCCUTCHEN.

The amount of material which the New Era graders remove in a minute depends entirely on the material. There is some material it would move right straight along, and load a wagon every 3 or 4 minutes. I would expect to have a steam shovel loading into wagons something over 600 yards in ten hours.

5289 Mr. Noyes: They worked one shift on that work. 10 hour shifts; they had 2 machines going all the time, and did 80% of the work in 3 months.

Mr. Dillman: I would not expect a steam shovel to move 18,000 yards a month, as I would not expect a steam shovel to work 100% of the time; that would be 30 days in a month. I would expect it, if it moved 600 yards a day, to move in a month 12,000 to 15,000 yards.

Mr. Noyes: When I say they did 80% of the work in 3 months, I mean during the months of October, November and December, 1908, which the force account shows.

Mr. Dillman: The work of a steam shovel will add 5 cents more 5290
a yard, because it costs more to operate a steam shovel than a New 5291
Era grader. For the same cost I do not think the steam shovel will handle as much as a New Era grader where you can work both to advantage. A steam shovel is more suitable for sidehill than a New Era grader.

From my knowledge of the cost of operations of steam shovels, I would consider about 5 cents would cover the extra cost of steam shovel operation per yard over the cost of New Era grader operations. At the same time, this assumes that both could be used to good advantage in this pit; which might not be the case at Pilarcitos at all. I have not assumed in my estimate that that is the case at Pilarcitos. Assuming that a steam shovel, working full time with 5292
interruption, would remove 600 yards a day, you could count on its removing on the average for a month 12,000 to 15,000 yards. You have considerable interruption often times with a New Era grader. No machine works 100% of the time; a New Era grader does not any more than the steam shovel. If it is hauled with stock, there is the matter of stock and harness, which may interfere with the operation of the grader. The grader itself needs sharpening, and then it is liable to interruption from the breaking of its various parts. Neither of them is a 100% machine. The 12 horses which are ordinarily put on a New Era grader would cost $1.25 apiece; that is $15; the men required are two drivers, one behind and one in front; one man upon the machine, and an extra man; that would cost practically another $15. It would cost $30 a day to run a New Era grader. I think it would cost probably $50 to run a steam shovel of the kind that I would use here. It would cost about 70% 5293
more for daily operation. With a New Era grader you would remove 19,500 yards a month, and the cost of that is $30 a day, and in the other case you would remove from 12,000 to 15,000 yards a month, at a cost of $50 a day. I would consider 19,500 yards for 30 days was a very high average for New Era graders to make.

It would cost about 5 cents a yard more to load with a steam shovel than a New Era grader in my experience; I don't know what the other man's experience is. If a steam shovel is worked continually as fast as it could swing, it would move more than 600 yards a day, but I know that it does not do it in loading wagons. If you 5295
should get 15,000 yards, and its maximum capacity without interruption was 18,000, that would be a good operation. I think if you got 26 days in the month for the steam shovel on the average, you would do very well, and I would try to reach 26. I would not be very happy if I did not get more than 60% of its rated capacity on an

average. I would expect to get 75 or 80 percent. The rated capacity of my 600 yard shovel is considerably more than 600 yards, and I would expect a shovel that delivered me 600 yards to do it under favorable conditions every day's work of 10 hours. There would be no interruptions which are accounted for in the short time in the month. If repairs were to be made Sunday, and it could work 6 days in the week, I see no reason why it could not load 15,000 yards
5296 into wagons.

Mr. Searls: Mr. Dockweiler called my attention to the computation based on this table here, that there were 61 excavating days figured on in this month, and 39,000 yards were removed, and that would mean 640 yards of excavating per day.

Mr. Metcalf: Yes, that is about right; 638.

There were 3 graders in the contractor's equipment; when repairs were being made, one would be laid up; this operation shows 61 working days with 3 machines. They were all in the same pit.

Lawrence

Witness: W. B. LAWRENCE for Plaintiff.

CROSS EXAMINATION BY MR. SEARLS.

Mr. Metcalf: I have here some sheets of corrections which Mr. Lawrence has made on the pipe schedule, which embodies the original costs of certain of the pipe lines, from which the latter costs on present day labor prices were derived.

5297 Mr. Lawrence: Page 10 and 11 are re-written to insert the original wage schedule, and segregated costs; also a certain correction in the distribution of carpenters' time, and an error in expanding foreman's wages. It does not make much of a difference in the net results.

Mr. Metcalf: I think simply in the segregation of the foreman's time; in general it simply adds the cost figure.

Refer to page 11, where you see the total amounts, the amounts now for the year 1913 is $105,059.43, as against $105,639.97, so that the change isn't very material in the total amount. It is merely a question of segregation. The original costs in the year when it was
5298 laid in 1898 was not given before.

CROSS EXAMINATION BY MR. SEARLS.

The source of my information for the weights in this exhibit is taken from the specifications of contract. They are not actual weights of pipes based on my own record, but are taken from the weights which are required there. In the Alameda pipe line we had those weights from our records on page 1, which were obtained by weighing into the shop by the party that hauled the plates, or some

such record of that kind. This is the weight of the plates which I have taken from the memoranda on the bills, which were checked with the weights, and does not include the rivets. It is the weight undipped. Referring to page 10; in resolving my 10 hour day into an 8 hour day, I expanded it on the basis that only .8 as much work 5299
would be performed per man in 8 hours as in 10 hours. I have not had any experience in handling men, outside of the Spring Valley Water Co., and my experience has been limited to work done by the company itself and contractors. I had experience with contractors in the construction and excavation of the ditch for the Crystal Springs pipe line, and the Alameda pipe line. I was connected with the company then more as regards the material and keeping things on the ground, and checking up the yardage for the contractor. I did not have anything to do with keeping the cost records of the contractors, and do not recall the wages he was paying at the time for his help. I cannot recall any work in excavation on the Peninsula comparable with the Spring Valley work, if you exclude public work. My judgment as to wages is based upon my experience with the Spring Valley Water Co., and such work as I have seen done for the public. I remember the San Andres pipe line work from 5300
Bald Hill Screen Tank to Baden, but I have not the data here as to the number of working days on that job. I can furnish it to you. It may be possible that some of them worked Sundays, but not as a 5301
general rule. That work was done during the summer and fall. Possibly it would take longer to do the work with more men in 1913, because I could not segregate in my mind whether they could work to advantage. In figuring these costs, I expanded the number of days to the 8 hour basis, and I figured it would take more days. I simply took the number of days that appeared on my records when 5302
we worked 10 hours a day at this, and expanded that to 8 hours a day, and then applied the rate. This was the excavation of the San Andres pipe line ditch, and was done by the company's men, and not by contract. In making up this table, I expanded the number of days, and applied the rate, but I did not consider the time—the result shows for itself what I have done on the table. If I were to assume that the work had to be done within the time that the original job was done in, I would have to consider that before making an answer as to whether it would make any difference in my table. I have not considered that phase of it. I am applying the same method that was done, the number of days, and expanding them, and using the 1913 rate. It might be possible that the company might find that it would be better to hire a little larger crew to do the job in the same time, but I have not considered that phase of it. 5303

If you had twice as big a crew, I do not know that that would necessarily mean but one general foreman. If you strung the men out for 2 or 3 miles, it might require another general foreman. In

this case here there was one general foreman. I assumed the same way the work was done, and the same method in which it was done. It is my recollection that the item of carpenters includes all labor listed as carpenters, and the original cost that was received was $2 a day and above that amount. In my original sheet I have 544 carpenter days, and on this sheet only 44; I have distributed that by allowing 44¾ days to the general account, of which I have no segregation, and added 500 to the bridges, piers and blocking on page
5304 11-A. I think if that is added up it will give the 500 days there. I discovered the error in the former sheet myself. The carpenters for which I have charged up 44 days were in the general work, as on the bridges for crossings and such things. I have not included them in my trestle work. I have no authority for the 44, but I know there is some work done along in that line, and I put 44 in there, and 500 in the other. Where the records do not show, I have taken my old sheet and segregated these charges according to my own judgment, but I do not think there are many cases where the records do not show it. The case of the carpenters is one.

One of your men called my attention to the watchmen; he thought it should be different on the Merced branch—that is shown
5305 on page 35, under excavation and fill, where I have got watchmen 164, 198, and 31 days. There is no record as to the apportionment in that case. There was some lagging of the trenches on that line, and I presume the carpenters were there, but as I say, I have not the exact place for the segregation of that account. At the time we built this line, we had carpenters lagging the trenches. For lagging trenches, putting in supports to throw dirt upon and then to shovel it out on to the bank, you do not use laborers for that. I am quite certain that carpenters were actually hired to build the lagging for
5306 the trench on this San Andres line. We paid in those days $2.50, $3.50, $3.74, $2.89, $2.49 and $2.99 per day. I expand that to $5 a day. I do not know that you could get an inside finishing carpenter for that, but carpenters wages are $5 a day down the Peninsula at the present time. We hire carpenters who work with dressed lumber to lagg our trenches, and also use them on form work for concrete at $5 a day.

Referring to common labor in 1898, where I show a charge of $1.15 to $1.89 in my old sheet; I have not changed that. The board has been added to that to get it all down to the same basis. I think that $1.15 in that case might have been a water-boy, but they are all brought in this to a standard wage. I did not add board in my first exhibit, but it is included in the new one. The $1.15 is evidently a
5307 water-boy, and includes board. I had forgotten, but the board was included in my first exhibit.

Questioned by Master.

There was about 49 cents added at that time for board.

CROSS EXAMINATION BY MR. SEARLS.

In 1898, for a 10 hour day, I think we were paying labor $1.64 in some of these cases. Take $1.15 from $1.64 and that is 49 cents; the $1.15 a day and board, or $1.64 cents without board, we paid labor those days. There are various wages paid on that job. Some of the men got $1.75 a day, some $1.89 a day, and some $1.64 a day. I am quite sure I have included their board. There are various rates. They are all segregated here, labor $1.75, $1.64, some at $2, some at $1.89.

Questioned by Mr. Greene.

Referring to where I have $1.64 opposite 11,462 days; if you subtract 49 from $1.64 that makes $1.15, and that was the rate that was paid at that time. 5308

Questioned by Mr. Searls.

As near as I can remember, that was the prevailing rate at that time. If my memory serves me correctly, during the course of this job the wages were raised. We had to pay more than we did at the start, but I would not be certain as to that. If the wages were raised, it would not destroy my comparison of costs, as I have used the same number of days at that rate and expanded it, and that is included in my table. In expanding my wages to 1913 rates, I use 8 hours and $2.50, as that is the prevailing wage in 1913.

SEVENTY-FOURTH HEARING. DECEMBER 7, 1915.

Witnesses: W. B. LAWRENCE for Plaintiff.
F. C. HERRMANN for Plaintiff.

(Certain corrections noted in the transcript). 5309

Discussion as to correctness of statement of Counsel for Plaintiff appearing on page 5293 of the transcript, wherein was said "This "record which is present here shows that these graders moved 39,000 "cubic yards a month"— This was in relation to testimony of Mr. Noyes, appearing on page 5289 of the transcript, in which he testified that there were 117,000 cubic yards in the dam, and that 80% of the work was done in three months, or 93,600 yards. 5309-5311

Witness: W. B. LAWRENCE for Plaintiff. Lawrence

CROSS EXAMINATION BY MR. SEARLS. 5312

In figuring my 1913 reproduction costs for pipe lines and excavation work, as described in Exhibit 99, I considered that all this work would be done with exactly the same methods and the same tools

as the original job. I have had no experience with excavating machines, and do not know whether or not it could be more economically done that way. I know nothing of the cost of operation of excavating machines. The Spring Valley Water Co. had undertaken the construction of the Calaveras Dam in 1913, but I did not use the wages which were being paid at the Calaveras Dam for the hours of work, on account of its isolated position. I think the Calaveras Dam is further from San Jose than the Pilarcitos Dam is from San Fran-
5313 cisco. It is 6 miles from San Jose to Milpitas, and from Milpitas to Calaveras it is about 9 miles, which would make a total of 15 miles. From San Francisco to Pilarcitos it would be about 24 miles, and from San Francisco to Millbrae it is 17 miles.

I cannot recall any pipe lines laid in the year 1913 by the Spring Valley Water Co., nor the number of common laborers that were working for me on the Peninsula System in that year. I cannot recall, without looking at the record, how many carpenters were employed, or how many teams. We keep the time books at Millbrae, and the payrolls are kept in San Francisco.

5314 Questioned by Master.

I am dealing only with reproduction in 1913, and I have taken the wage scale as of 1913.

CROSS EXAMINATION BY MR. SEARLS.

Recently we have hired teams on the Peninsula work for hauling materials, and it does not require many teams for ordinary requirements, and when we get teams in that way, we simply hire a team for a day or two, and do not have a standing contract with people there to furnish them. It depends upon the amount of other work that was going on whether you could expect to get a better daily rate from the team contractor than you would get if you hired one team for one day, or for two days. Assuming that there was not any other work that would require all the teams in San Mateo County, and that the contractors were ready and willing to do business, you might expect to get a better rate for keeping all their teams occupied during a considerable period of time, than for hiring one or two for a day or two at a time, but I do not say that you could. The rate—which is a
5315 union scale—for a four-horse team and driver, in San Mateo, is $3.50 per day. I think it would be a logical deduction from Mr. Herrmann's testimony, that the cost of a team driver, at Calaveras is $7.75 for a four-horse team, as against my $8.50 based on a 10 hour day
5316 at Calaveras, as against my 8 hour day. I think, even on a large contract, that if you could get a four-horse team in Calaveras for $7.75, on a 10 hour day, that you would have to pay $8.50 for a four-horse team in San Mateo County on an 8 hour day.

Recently, at Sunol, and in the same vicinity, they have been paying $5 a day for a two-horse team. Referring to page 35-P of the ex-

hibit, which shows a San Mateo County job in 1907, the Merced branch of the San Andres pipe line, there we paid $5 for a two-horse team, and $7.50 for a four-horse team. That was in the summer and fall of the year 1907, and we worked 8 hours a day. On the Pleas- 5317
anton-Sunol job we worked 9 hours a day. With the San Andres line in 1898, and the Merced job in 1907, and another job on the Stone Dam Aqueduct, we maintained construction camps for the men. We generally maintain them in those larger jobs, and the camps were wooden camps. On the San Andres 44 inch pipe line, laid in 1898, we had a wooden camp at Millbrae. We did not move our camp as the work progressed. If the work had been done by contract, whether the contractor would move his canvas camp along with his men or not, would depend on the possibility of his getting a location for it. I do not think a contractor building such a line in 1913 would have used a canvas camp instead of a wooden one under the conditions we had 5318
there. There were teams that were stabling in the vicinity of the camp, and they took the men back and forth on their own time. We did not own the teams, they were hired, and they took the men back and forth, as I remember it, without charge to the company other than the charge for the work which they were doing.

It has been the practice of the company to take good care of their 5319
men, and to house them in a wooden camp. The common laborers are not organized in San Mateo County to my knowledge. I think you would get better labor for $2.50 a day and 8 hours than you would for longer hours and less wages. I think you can get a better class of labor for an 8 hour day than you would for a 10 hour day, and they would do better work than a man that worked 9 or 10 hours. The man that works 8 hours a day will, per man per hour, do better work than 5320
the man who works 10 hours will do per hour, but how much better work, I do not know. 5321

It has not been my experience that the racial differences between the different classes of labor that make up the common labor element constitute a bar to the effective unionization and organization on their part. I have had Portuguese and Irishmen, and some Italians, but I have not had other nationalities, so I do not know. It has not been my experience that the Italians usually stay together, and the Irishmen stay together, and there was not a great deal of fraternization between them. You could not take the Calaveras crew and put them into 5322
the camp in San Mateo County, and work them the same hours that they are working at Calaveras, and at the same rate, because you will have mechanics who are organized working with them, and I think it would be only a short time before there would be dissatisfaction and organization of some kind. San Mateo County is a union county, and they would organize and create trouble. I do not know of any objection in the laying of pipe to having the two classes of labor working on a different scale of hours.

5323 Referring to page 7, in column 5, the figures in parenthesis were actual costs at Millbrae; other figures were interpolated according to the diameter of the pipe, and the figure 16 cents per lineal foot for labor cost was an interpolated figure. The 44 inch pipe was laid in 1884 and 1885. Mr. Carey was at the tar kettles on Beale Street, in San Francisco, for awhile. Mr. Carey's testimony in the last Spring Valley case, to the effect that the labor on this dipping cost 5.4 cents per lineal foot, would not coincide with my interpolated figure, but I do not know from what he derived his cost. Mr. Carey's statement
5324 is as to 30 inch pipe, whereas I have the labor cost for dipping the 30 inch pipe as 11.1 cents. The San Andres line is a 30 inch pipe, and my figure is 11.1 cents, and is an actual cost. That is from our records for dipping pipe at Millbrae. If the statement is true, it would show that the San Francisco cost was very much less than the cost at Millbrae, but I do not think the 20 foot lengths he mentions there are true, because I do not know of any pipe we manufactured of that length. In interpolating these costs, take column 5; for the labor
5325 cost there we had, on the 22 inch, 7.5; the others were interpolated according to the diameter of the pipe. In regard to all these costs, we have in the records at Millbrae the labor and so forth, as given here, which is contained in some ledgers, and records of all kinds, such as diaries kept by my assistant. There was never any systematic method of cost accounting kept prior to 1907 or 1908, but the original costs here are from records. Some of those records are the summary of some of the jobs that were gotten together, and worked up after the job was completed, and others in more or less detail. Those sum-
5326 maries were based on actual time worked and wages paid.

In making these computations, I had my memorandums of the summaries of the costs, and that is what I used. It is possible for a person not intimately connected with the work when it was done to take my records and find today what the original cost of the work was, although it would take a long while to do it.

Questioned by Mr. Hazen.

The records that I have cover the expenditures that went through my office, and there were often other expenditures paid from San
5327 Francisco that did not go through my office, and that are reflected from my records.

CROSS EXAMINATION BY MR. SEARLS.

In 1898 the foremen were paid from $2 to $5.30 per day, and when I expand to 1913, I raise the general foreman to $6 per day, and allow for two, and raise all the others to $4 per day, but on the 16 day foreman, at $5.30, I do not know who that was, though it is on my record. Some of the foremen were paid by the day, and some by the month in 1898. I have it here 173 days at $3.99; that man was paid $3.50 a day and board, and evidently was a monthly man, but I am

not certain as to that. I could not say how many of these men were "straw bosses"; that is taken from the record. I would have to investigate it further by talking to the men who were on the job. My record does not show what the destination of these men was, other than foremen. They were all paid different rates of wages. I reorganized, and put them all on the same basis for the 1913 rate. I 5328
figure that we would get a good man to fill a particular position of "straw boss" for $4, and I do not think you could get a good man and pay less. The rates that were paid for "straw bosses" varied according to ability. The 44 carpenter days in that same column evidently does not include a helper. The wage of $3 was a general wage we paid then to carpenters. I figure that on this work we would use straight carpenters, and no helpers, and I think that would be an economical proposition, instead of having a carpenter with his lower paid helper to do a great deal of the work. I do not know of any other contractor doing large carpenter jobs who follows that practice.

Referring to page 11; the man that went inside to paint the joints was paid more than the man who painted on the outside. There are 5329
9 trestles between Baden and the screen tank. That refers to the 44 inch line. The 37 inch line is beyond Baden, and has about 1400 feet of trestle, I think.

Q. The information given to Mr. Bailhache of my office, by Mr. 5330
Sharon, was that 10,000 B. M., under item 12, refers to the Baden Screen Tank trestle, and that the items under item 13 refers to the trestle north of Baden; now if that is the case, Mr. Lawrence, there are 10,800 feet B. M. of lumber in the Baden Screen Tank trestle, for which you show a total cost of carpenters and labor here $3,126. A. I think the items 12 and 13 should be taken together, because it has 540 feet—I won't say 540 feet, I will say a considerable distance that is buried under the ground. Q. Is that not north of Baden? A. There is no 44 inch pipe north of Baden.

Our records did not show the distribution of carpenters, and my distribution according to this schedule is assumed. There are other trestles on that line; there are 9 between the screen tank and Baden, 5331
but evidently they are not shown in the inventory, and I have evidently included in my costs here, the cost of items which are not included in the inventory. I will have to verify that.

Questioned by Master.

The meaning of concrete piers and blocks for the trestles is supports for the trestles.

CROSS EXAMINATION BY MR. SEARLS.

In 1898 we did not pay our outside men for painting joints any more than our ordinary labor. When I expanded to 1913, I gave them $3 a day, because I think it would be a little more difficult, and a nastier job, and people are a little more particular now than they

were in those days. Referring to page 11, the item of road work, I think, covers certain changes in the county road that we were requested to make by the Board of Supervisors, and also covers getting
5332 rid of our surplus dirt before we could proceed with the laying of the pipe. It was necessary to obtain permission from the Board of Supervisors to lay the pipe, and they stipulated that certain things should be done regarding that, and that we should arrange with them where we could dispose of our surplus dirt. That road work was done with our regular men and teams, and not by contract.

I did not work out my 1898 costs for excavation per lineal foot, or per cubic yard, and I could not tell you what it would be. If my excavation of trench is given under 1913 as $48,317, and to that I add 44.8% of the general cost, making $47,099.66, it would make that just
5333 about $1 a yard in 1898. I have not figured it.

Mr. Hazen: That is your labor, only, isn't it?

The Master: Labor only, Mr. Searls?

Mr. Searls: Labor and backfill also.

Mr. Hazen: It does not include anything for material?

Mr. Searls: No.

The Master: Excavation and backfill: Is that right, Mr. Searls?

Mr. Searls: Yes.

Mr. Lawrence: I do not know how much the cost of excavating had increased between 1887 and 1898; I did not give that any consideration. I would not want to guess at it.

Referring to the minutes of the Spring Valley Water Works, dated July 28, 1887, page 132, book D, showing that in that year the contract for excavation for the Alameda pipe line was let to the Risdon Iron Works for 41 cents per cubic yard; in 1898 I show a cost of $1 per cubic yard, but the man who had the contract with the Risdon Iron Works went broke. I do not know what the work cost him, but
5334 I know that he failed. He was not running any other contracts at the same time to my knowledge. The fact that the contract price of 41 cents per cubic yard there in 1887 is ¼ of what I make it for 1913, is not a fair comparison with this 44 inch San Andres pipe line, and anyway, it depends entirely upon the location. I have not considered that, or gone into those figures, but from generalities this pipe line was along the county road a great portion, and interfered with by gum tree roots, and in keeping traffic open. It was a heavy clay soil condition, whereas, with the Alameda pipe line a great deal of it was along roads that were very little used. Some of it was along county roads, and some of it through fields, and so was the San Andres for that matter, but it was different soil conditions. I would not want to
5335 say, without looking it up, what proportion of the Alameda pipe line was along county roads; I should say 17 miles of it out of about 28. Some of that which is included in the 28 is trestles and marsh. I am adding those figures in my head, so it is hard to say. I think I have

included Bane Avenue as part of the county road in my 17 miles, but it is very difficult to get at that. The portion of it that was laid along the county road was included in the Risdon Iron Works contract. In the Alameda pipe line there were extra allowances for that contractor in order to help him out. Those were extras not included in the original contract.

It was a sub-contractor that went broke on this contract; not the 5336
Risdon Iron Works; they let it to a man named Baldwin, and I understood they let it at the same figure that was specified in their contract. Mr. Moore told me that they let it at the same price and the same figure that they took it from us for. Referring to page 12, Alameda 54 inch pipe line, we paid foremen from $100 to $150 a month. I could not tell you whether we had more than one foreman or not. That work was started in June 9, 1903. We put the full pressure on 5337
the new pipe January 28, 1904. I do not think that we had more than one foreman. Referring to items for labor, excavation, and fill, $2.50, $2.71; labor miscellaneous $1.96, $2.07; the $2.71 is with board. The miscellaneous includes the backfill, and also other items. I will have to look up and see whether we paid less per day for men working on the backfill than for working on the excavation; I don't know how that comes about. It looks, offhand, as if the bulk of labor on backfill was about $2.50, taking the number of days there. That was what we were paying for common labor in 1903, except that the hours were different. 5338
I do not know whether the cost of teams varies approximately with the cost of wages, but in getting up these schedules, I have expanded it from the 9 hour basis to the 8 hour basis, using the rate that I thought would be applicable in 1913. I do not think that the cost of teams varies approximately with the cost of wages. The teams in this case were local teams, and it depends upon the supply and demand. In my opinion you would have paid $8.50 for a four-horse team and driver in that year. You pay $5 to $6 for a four-horse team and driver now. I would not infer that 1903 was a year of high wages. The same rate of wages has continued since then.

I have charged all my blacksmiths labor into excavation, because 5339
it was all principally sharpening tools for the men digging the ditch. We hired our teams, and they did their own shoeing. The figures which I have in 1903 include board at 71 cents per day. I did not give you the original schedule on the unit cost, because I did not know it was going to be required. There was probably a man as helper for the blacksmiths at laborers wages, but I did not include him under the designation blacksmith's helper. We have had bridges and forms for concrete for carpenters, which would not be classified as rough carpentering, except the rough forms for concrete. You can get rough carpenters for lower wages than you can first-class finishing carpenters, but I think there would be considerable difficulty in doing so in 5340
San Mateo County. I did not assume that all my carpenters would be

drawn from San Mateo County, but they would be drawn from there and vicinity, and I think if you had a rough carpenter on the job, you would have trouble. I imagine a rough carpenter would get lower wages than a finishing carpenter.

I had something to do with the Pleasanton-Sunol pipe line, and we had no trouble with leaks in that pipe. There were one or two elbows that were riveted; the rest of it was slip-joint. Referring to page 29;
5341 the cost of laying the pipe in the old Hadsell ditch; we did some trimming in the bottom of that ditch, and there was a variable depth according to the deposit in the ditch, and it was necessary to obtain the proper grade.

Mr. Searls: We took the length of the pipe line laid in the Hadsell ditch from the company's map as being 7,200 feet, and found that that was 26% of the entire length of the line. We assumed that the cost per cubic yard for excavation was twice the cost per cubic yard for backfill; on that basis we figured that the original cost, which you would have had to meet if theHadsell ditch had not been there, was the difference between $14,941, which was your actual cost, and $17,-575, which we assumed to be the cost if the ditch had to be excavated entirely, and dividing them by the total cubic yards in the inventory, which includes the cubic yardage in the ditch, we got a figure of 50 cents per cubic yard, cost of excavation of backfill 1908 to 1909. I have also included the original Alameda pipe line contract cost.

5342 Mr. Hazen: I understand that this excavation was made excluding the excavation that was not done in the Hadsell ditch. I went over that, and it is quite clearly my impression that this figure in the inventory only represents the excavation that was actually done, and that if all the excavation for all the pipe line were included, the figure in the inventory would be certainly raised.

Mr. Searls: On this basis I have computed the cost of excavation as 50 cents per cubic yard for excavation and backfill. The backfilling, of course, was done on the Hadsell ditch. The item shown in the inventory for backfill is the same item as for excavation, and as the backfill was actually done, it is reasonable to assume that the excavation yardage does include the ditch.

The computation was offered in evidence and marked "Defendants' Exhibit 107".

5343 Mr. Hazen: We will concede that Mr. Lawrence's figures practically check your testimony if you use his 80% increase. We do not concede an 80% increase.

Mr. Searls: I mean, if you take 41 cents and add Mr. Lawrence's estimated increase in wages at 80%, you will come out with about 73 cents per cubic yard for excavation and backfill.

The Master: Mr. Hazen's final statement on page 4391 on this 54 inch Alameda line, that is figured along the state road, was $2.25 as compared with $2.66 actual cost—not the extended figure.

CROSS EXAMINATION BY MR. SEARLS.

I adopted $4 a day in 1913 as the proper wage for foremen, and 5344
used it everywhere. I did not increase laborers. This is on page 28 in Alameda County, Pleasanton-Sunol pipe line. I assumed 8 hours for the whole system in reproducing it in 1913, in Alameda County. Calaveras, where they are working 10 hours, is in Alameda County, but it is isolated. This Pleasanton-Sunol pipe line was constructed in 1908 and 1909 with 9 hours, and has not been expanded to 8 hours in 1913. I would like to ask permission to change that.

I used the $8.50 schedule for four-horse teams in Alameda County in 1913. Where I have the boiler-makers working without any helpers in 1908 and 1909, and reduced their wages from $4.70 to $4.50 in 1913, that is an error. There is board—$4 a day, and board in 5345
1908 and 1909, and that is carried at $4.50 in 1913. Referring to page 35, the last item of which is a charge for livery; that is an error that was called to my attention by one of your men in looking over the accounts I have in the office. I informed him at that time that it was hauling boiler-makers back and forth from San Francisco during some car strike that was on. I made further investigation, and found of this figure that there should be charged to excavation $282; to laying pipe $244, and to engineering $206. That would make a difference of about ½ a cent per yard in the total yardage of the line.

Mr. Greene: We have finally the figures of the four witnesses on 5346
the buildings, and they come to the following totals: Mr. Parkinson, $339,496; Mr. Hazen, $322,449; Mr. Dockweiler, $275,692; and Mr. Dillman, $348,330. Mr. Parkinson's figures were used by Mr. Hazen, but not adopted in toto. Mr. Dillman is the highest of the four, and in between Mr. Dockweiler and Mr. Dillman come both Mr. Parkinson and Mr. Hazen. The average between Mr. Dillman and Mr. Dockweiler is $319,260, as against Mr. Hazen's $322,449, or in other words, taking the average of the Defendants' witnesses, and Mr. Hazen's figure, there is a difference of less than $3,000 shown.

Mr. Metcalf: The averages are about the same. The average between Mr. Dockweiler and Mr. Dillman on the ranch houses is $169,746. as against $170,141 by the other witnesses.

(It was suggested by the Master that Counsel determine among 5347-5348
themselves as to a method of give and take, by which they could get the question of the valuations on the buildings out of the way).

CROSS EXAMINATION BY MR. SEARLS. 5349

The Merced branch of the San Andres pipe line was laid between Baden and San Francisco. It ran up to Ocean View Pump, which I do not understand was a great distance within the limits of the City and County of San Francisco. That is the point where it crosses the county line south of the Ocean View pump.

Referring to page 11-A, item 65 cents a cubic yard for backfill;
5350 I could not say how many cubic yards of dirt a laborer could throw into a trench in a day. It depends upon the character of the ground, and the conditions. I have taken this figure from results we have here of the actual time engaged in work at that time. I have not figured it by performance per man as compared with my labor cost. I would not attempt to say whether a man would throw more than 10 yards, as I never watched them for that.

Mr. Dillman: If he was working 8 hours, he would throw back not less than 10 yards.

Mr. Lawrence: Assuming that he threw back 10 yards in a day, and we paid him $2.50 a day, that would make my labor cost 25 cents, or in other words, my supervision and equipment charge would be nearly twice as much as my labor charge, and that is not a fair relation, because in this case the dirt was thrown back and
5351 thoroughly tamped around the pipe by hand, even with the top of the pipe, and then the rest of it was filled in loosely. Where road crossings are, it is tamped, and the top is taken care of, and along the road it is always cleaned up and evened up. It is always the practice of this company to do it in that way.

Mr. Dillman: Whether you can backfill and ram 10 yards per day with one man would depend entirely on the amount of tamping done. With the normal amount of tamping, and in an ordinary trench, the man who did the filling would not also do the ramming. The chances are there would be one man ramming, and two or three throwing in.

5352 Mr. Hazen: I think where tamping is done, it is the common practice to have two tampers and one shoveler.

Mr. Lawrence: That is the practice along this line. When the dirt is thrown in, care is taken that no large lumps go in with it; it is tamped under the pipe firmly with little wooden tampers. When that is thoroughly tamped, they come with little wooden tampers up the side to possibly two-thirds the way between the bottom of the trench and the pipe; then it is all evened up, and the surplus hauled away. I do not know what an individual man could do in a case of that kind, because I never figured it that way.

Herrmann Witnesses: F. C. HERRMANN for Plaintiff.

5353 DIRECT EXAMINATION BY MR. GREENE.

This year, in building the different structures at the Modesto Irrigation Works, which was done under contract, and for cash, I have the following items on rip-rap; Dry Creek flume, 3,060 square feet, at 12 cents a sq. foot; Rairdan Fill 3,600 square feet at 16 cents a sq. foot; Salter Fill 3,700 square feet at 16 cents a sq. foot; Indian

Hill Fill 3,000 square feet at 16 cents a sq. foot. 11 small structures on lateral No. 6, aggregating 7,500 feet at 5 cents a sq. foot; 9 structures on lateral No. 3 aggregating 5,000 square feet, at 5 cents a sq. foot. That makes a weighted average over those items of 10.2 cents a square foot. The last two items of the structures, the material used for rip-rap is hard-pan, for which the contractor is paid for excavating whatever part of it he does excavate in building the structures. That varies with each individual structure. He gets 5354
a price for excavating hard-pan, and then he gets this price for putting it in his rap-rap below the structure. Where there is a lack of hard-pan that has been excavated, he must excavate other to complete the rip-rap. In all those structures the rip-rap is largely hard-pan.

Questioned by Master.

There are two types of hard-pan over there, one of which is somewhat of a clay, but very hard, and the other very close to rock. Except for the local name of hard-pan, you would call it rock. This rip-rap is laid up neatly, but it is not paved in the sense of the pavement on the Howard Cut. It compares with the rip-rap on the Pilarcitos and San Andres Dams. The difference between the 12 cent item and the 16 cent item is just the contractor's idea. These are actual contracts, and this is the lowest bid in each case. It is 10 to 12 inches thick, and is supposed to be made from one man rock. In regard to that 12 cents, the contractor is allowed to use for rip-rap fragments of concrete of the broken piers he has to take out anyway in order to construct this structure, the concrete piers being there at the present time to support the present structure.

Questioned by Mr. Searls.

The largest individual job was Salter Fill, 3700 square feet. A 5355
contract for Salter Fill included fill itself by the hydraulic process, the construction of a reinforced concrete canal in the top of the fill, and rip-rapping a portion of the up-stream slope of the fill. The rip-rap was 10 to 12 inches thick, and was not laid with a smooth surface as on the Howard Cut. The Howard Cut is paving. The contractor got most of his rip-rap within 75 or 100 feet and that is true of all these jobs, with the possible exception of 2 or 3 of the smaller structures in the laterals. I am familiar with the prices that were paid for all the elements of the contract on these jobs. It is not possible that in any of them the contractor bid high on the rip-rap element, and much lower on some of the other elements, with the hope of capturing the contract, because this rip-rap item is comparatively small; also this was open, competitive bidding, in which we had all the way from 10 to 15 bidders. My opinion, from analyzing the bids is that very, very seldom were they unbalanced. 5356
These are the lowest contracts for rip-rap. I do not know, offhand, the lowest price bid for rip-rap in the Salter Fill. If this was the

lowest contract, and the rip-rap element was higher than some of the others, it might possibly be some indication that the bid might have been unbalanced, but my impression is that that was not the case.

Referring to the specifications read on the Wild Horse Dam, where the contractor bid 6 cents for rip-rap; I am not sure that he made 3 cents on the job; as I understand it, from the testimony given by Mr. Noyes, most of that rip-rap was taken out of rock fences, and there was no quarrying or anything necessary to get the rip-rap, and that price of 6 cents merely included the transporting of that rock, already quarried, to the place of use, and putting it in place, which is not at all comparable with the Pilarcitos or San Andres
5357 conditions. If 3 cents was the average cost of the work, there would have to be added to that the cost of quarrying, and whether that would amount to 7 cents per square foot would depend entirely on the material, and the ease with which it was gotten out.

In my figure of 5 cents, the contractor is paid for excavating hard-pan, whatever of it is excavated in building the structure. In some of the structures the amount of hard-pan excavated is in excess of the amount necessary for rip-rapping; in others it is not equal to the amount that is necessary for rip-rapping, and the contractor has taken all that into consideration in bidding his 5 cents. The specification does not show that the rip-rap was to come from that portion of the hard-pan, but I know the conditions, because the work is being done under my directions. On the Salter Fill, the lowest
5358 bid was by Bates, Borland & Ayres, 80 cents a square yard; San Francisco Bridge Co. $1 a square yard; Messmer & Rice $1.50 a square yard. Tibbitts Construction Co., to which the contract was let, $1.50 a yard; F. Rolandi $1.50 a yard. Those are square yards, and they must be divided by 9 to reduce them. On the Rairdan Fill 90 cents is the lowest bid; the Tibbitts Construction Co. got the job at $1.50. Indian Hill Fill, the lowest bid is $1 a square yard; Peart Bros. got the contract at $1.50. On the Dry Creek the lowest was 75 cents, and in the contract it was $1.08. The structures on lateral No. 6, the 5 cents given already is the low one. That was ranging up to 17 cents. Lateral No. 3 structures, 5 cents was the low one. The last two were per square foot, the other one was square yard.

5359 The specifications for the rip-rap on the Salter Fill, speaking from memory, require that the rip-rap shall be about 12 inches thick, and shall be made of one man rock, and laid up to a uniform surface conforming to the slope required for the fill. There was no trench at the bottom of the slope. The rip-rap was carried out over the dam instead of trenching in. There are two ways in which rip-rap may be keyed on this sort of work; one is to carry the rip-rap down into the trench for a toe, and the other is that instead of carrying down into the trench, you carry it along the floor of the

natural ground at the base of the slope. In either way you obtain the same result. I do not know from what points the rip-rap on the Pilarcitos and San Andres Dams was obtained. From the character of the country rock there, I think it would have to be obtained from several points wherever harder points are available. I think more effort would be exerted in getting suitable rip-rap material at Pilarcitos and San Andres than would be necessary in the case of the Modesto Works that I have mentioned. The laterals that I spoke of were inside the district proper; the other is the main canal all the 5360
way from La Grange down through the district, perhaps only 20 miles. Part of it is in the foothills. The Dry Creek flume is not in the foothills; Salter, Riardan and Indian Hill are in the foothills. I do not know what the quarrying costs will be, as the work is not completed as yet. I do not know what it would cost to quarry the rip-rap in that district, but it would be somewhat less than quarrying rock. These jobs are very small as compared with the San Andres and Pilarcitos; the total square feet is about 26,000, while the total square feet in Pilarcitos alone is 26,000. In the Pilarcitos, or the San Andres, I do not think you would get all that rip-rap from one quarry. I do not know whether there were two quarries at 5361
the Pilarcitos from which the rip-rap was taken or not, but knowing the character of the Coast rocks that we have in these coast ranges, I know that you do not find large bodies of hard rock suitable for rip-rap.

I did not assume that the rip-rap was obtained at any definite point for the construction of Pilarcitos and San Andres. I think it would be obtained from a number of points within reasonable distance of the dam, and that it would cost in the one case about 10 cents, and in the other case about 15 cents a square foot. I did not make any examination to determine where it was obtained.

DIRECT EXAMINATION BY MR. GREENE.

Herrmann's data on flumes offered in evidence, and marked 5362
"Plaintiff's Exhibit 108".

In making my estimate of the cost of reproducing these flumes, I had in mind the excellent character of the flumes, and the workmanship, and the great care that was used in their construction. I have also had before me the cost of flumes that are more or less comparable that I have been familiar with, and that have been constructed under my direction. The cost of constructing the flumes of the main canal of the Modesto Irrigation District from Indian Hill and Dry Creek, a distance of about 20 miles, and consuming upwards of a million board feet of lumber, was as follows: Rough Oregon Pine, $43.70 per thousand in place; rough redwood $48.20 per thousand in place; 2 inch redwood planks, surfaced, $55.25 per thousand in place; 1 inch redwood $60.50 per thousand in place.

The battens and small lumber were surfaced. Those were paid for in cash by the Modesto Irrigation District March 14, 1903.

5363 The flume from the La Grange Dam to Mill Gulch, of the Modesto Irrigation District, having the length of 3700 lineal feet, the inside dimensions of the box being 6 x 12 feet placed on a bench on the bank of the Tuolumne River, the contract price for 360,000 board feet was $75.45, payable in 5% bonds of the Modesto Irrigation District. As nearly as I can find out from the officers of the District, and the contractors familiar with that work, a low price for the bonds would be 75% of par. If this figure be used as a basis, the cash price of the bid would be $56.58 per thousand board feet in place.

On March 4, 1912, the South San Joaquin Irrigation District let a contract for the construction of Hilts Sag Flume, which is something over 2,000 feet long, having inside dimensions of 9 x 12 feet, and being for a considerable distance on a high trestle. The contract price was $95 per thousand in place for redwood planks, and battens, and $65 per thousand for rough Oregon pine; spikes, bolts, etc., extra at 10 cents per pound, this all being payable in bonds—perhaps to a third party, I do not know just how that was. If these bonds be considered at 75% of par, these prices become $71.25 per thousand for redwood planks and battens, and $48.75 per thousand for rough Oregon pine, and 7½ cents per pound for bolts. As nearly as I can gather from talking with ones interested in the Irrigation District, and contractors and engineers, everybody who has been on the work, I think the assumption of bonds at 75% is fair. The La

5364 Grange contract was with the San Francisco Bridge Co., September 17, 1894.

Questioned by Master.

These are contracts that were made at the dates I have given for each one, and are not current bids. The Modesto flumes were September 17, 1894. The other date was March 14, 1903. There were two contracts about 10 years apart. The South San Joaquin Hilts Sag Flume is a very late one, 1912.

5365 Questioned by Mr. Searls.

The Modesto prices I took off the Modesto contract myself. In addition to those, there is the New River Flume, in Imperial Valley, which I built, and which is a large flume built in a measure comparable to Spring Valley flumes. It is about 1400 feet long, some of it being on a high trestle; the labor and carpenter costs on that was $25.51 per thousand for about 600,000 board feet of lumber. The price of lumber is not in there, because the lumber was in stock; some of it was new, and some of it was old. The rebuilding of the flume of the San Jose Water Co., in the Los Gatos Canyon, between Alma and Los Gatos, cost $72 per thousand in place, and was paid for in cash, the flume being approximately 2 x 3 feet box channel,

and there being used in it redwood planks 14 inches wide, which accounts for the high price of $72 per thousand. In the estimates of flumes that I have made, I was given the general prices by the purchasing agent of the Spring Valley Water Co. for lumber f.o.b. Millbrae as follows: Clear redwood, surfaced on 3 sides, which is used in the flume box, $32.40 per thousand; rough redwood $18.50 per thousand; rough Oregon pine $16.50 per thousand.

Questioned by Master.

That was in 1914, I think, and would not vary a great deal from 5366
the average of the years in controversy in this litigation.

Questioned by Mr. Greene.

Those prices were given to me as the price by the purchasing agent at that time, and I presume it was the price at that time; at any rate, that is the basis for this estimate, and if in going back over the years covered by this litigation the price is different, all that needs to be done is to add or deduct the difference.

Mr. Dockweiler: I have a price here for the different sticks. ½ x 4 common redwood $41.50; the batten, surfaced 3 sides, $13 a thousand clear. 1 x 6 clear surfaced 3 sides, f.o.b. San Francisco, $31.70. To my San Francisco price add $2.33 to Millbrae.

Mr. Herrmann: To that price at Millbrae I have added the cost 5367
of loading and unloading from cars to trucks, the hauling, the handling between the truck and the flume, including re-piling and assorting, and various things that are done with the lumber in the construction of these flumes.

Questioned by Mr. Searls. 5368

I got my information on that point talking with various members of the Spring Valley Water Co., Mr. Schussler, Mr. Lawrence, Mr. Sharon, and others. I added 5% for waste, which I consider a conservative amount that would occur in these flumes, because they are a crooked alignment. I added $12 a thousand for framing, and 65 cents a thousand for hardware. These totals I then rounded to the nearest round number. The hauling I have based on the experience of hauling with motor trucks in Calaveras. In 1913 we contracted the hauling of cement, and other materials, including a large amount of lumber, from Milpitas to the Calaveras Dam site, a distance of 9½ miles. The contract price for lumber was 30 cents per ton mile, plus 25 cents per ton to the contractor for handling at the cars, and the unloading on the job was done by the company's employees. These trucks were used throughout the 24 hours in order to hasten the work. The average time consumed was 4½ hours for a round trip from Milpitas to Calaveras and return. The time lost in unloading and loading lumber was 1 hour, so that the total time consumed per trip was 5½ hours. The distance from Millbrae to San Andres was 2½ miles, 5 miles for the round trip, and using the

same running time rate, and the delays as were experienced in Calaveras, there is consumed 1.17 hours per trip. Adding 1 hour to that for delay, we have a total time of 2.17 hours, or a truck will make 11 round trips in a day of 24 hours, carrying 4½ tons per trip, with a 5 ton-truck, or it would accomplish the work of 124 ton miles.

A truck for a 24 hour day would cost $50 a day, if you hired it; the upkeep being in the hands of the truck owner; dividing $50 by 124 ton miles gives you 40 cents per ton mile, or $1.50 per thousand
5369 for lumber from Millbrae to San Andres. I have considered that the cost per ton mile to the other various points where lumber would be hauled in the Peninsula System, would be at about the same rate as that for San Andres; while the delays would be more frequent, and the total time consumed in delays would be longer in the haul to San Andres than to other points, the difficulty of hauling over the narrow, steep, and crooked road to points beyond San Andres would offset this, and in my opinion, the reasonable price would be 40 cents per ton mile all over the Peninsula System. Lately in hauling 42,000 board feet of lumber from Milpitas to Calaveras by teams, the cost has been $5.17 per thousand, or 36.3 cents per ton mile. Nowhere in the Peninsula System will the hauling over the roads be as easy as from Milpitas to Calaveras, so that I think the 36.3 cents is a check on the 40 cents. The contract in 1913 was 30 cents, plus the handling; I have then taken in the main Pilarcitos flume, which lies on the west side of the San Mateo Creek, and have started with a base of $32.40 for clear lumber, and arrived at the price of $58.50 in place in the flume.

Questioned by Mr. Greene.

The difference in the different structures that I have listed here all lies in the haul, and in the handling from the traps.

5370 Questioned by Master.

I have used 40 cents per ton mile as my unit throughout, except in the Sunol I used 30 cents a ton mile, because the roads are much better, with no grades, and the hauling would be considerably easier. My figure for framing is my idea of what it would cost, from my experience in timber work. The figure, handling from the truck, means the re-piling, sorting, and caring for the ends of the clear lumber, and then picking it up with teams or otherwise, and getting it to the nearest point of the flume, and snaking it wherever necessary over hills to the places of use, and distributing it. The $12 is the carpenter work on the framing itself.

Questioned by Mr. Greene.

I figure that there will be a waste of 5% in the lumber that is purchased, by reason of the fact that the alignment of these flumes is crooked, and some damage will probably occur, even with the most careful handling. I have assumed in here that this is the
5371 number of board feet in the flume as it stands. If there has been an

allowance for waste, I have no business to make another allowance here.

My figure of 65 cents for hardware is from general experience, and very largely from figures obtained from Mr. Lawrence. There are all kinds of flumes built; I selected the flumes of actual cost in the Modesto District because they were built in much the same 5372
manner as the Spring Valley flumes are built. The ordinary flumes in the Sierras are not in any way comparable to the flumes of the Spring Valley Water Co., because no such care is used to make them water tight and serviceable. Usually no care at all is taken in the joints in the flumes that I have seen in the Sierras, and a good many of them leak. The 5 or 6 feet of snow that they will carry in winter in the Sierras is not nearly so heavy as the water that they carry in summer, because you have got to take 10 parts of snow to produce 1 of water.

Questioned by Master.

It is not customary to caulk these ordinary flumes, and very seldom to put asphalt on them. Caulking and tarring I have put in at 1½ cents per lineal foot in the schedule all the way through. The basis for that figure is from experience with the Spring Valley Water Co., and of my experience with the New River flume. That 5373
is one thing that Mr. Dockweiler and I can agree on. The excavation for the flume is about 50 cents a cubic yard for earth, $1.20 for loose rock, and $2 for hard rock. This estimate is based on an 8 hour day, as I believe that it would be necessary on the Peninsula, particularly in a case of this kind where most of the men are mechanics. From the information I have received, and from the steam shovel men, they would not tolerate working 10 hours a day in San Mateo County. The caulking and tarring are together.

Questioned by Mr. Searls.

I have seen the rules of the International Brotherhood of Steam Shovel Men, but Mr. Wilde, who is Secretary of the institution, is 5374
the man who gave us our information.

Witness: W. B. LAWRENCE for Plaintiff. Lawrence

DIRECT EXAMINATION BY MR. GREENE.

The lumber for these flumes was purchased the preceding years. Referring to the Stone Dam aqueduct, and the Sunol aqueduct flume; the lumber was purchased through competitive bidding, and delivered to the Stone Dam aqueduct flume at Sawyer Camp, and in the case of the Sunol aqueduct flume at Niles and Sunol. The specifications required that all of the lumber of the flume box proper should be absolutely clear redwood, free from knots, flaws, spots, pitch, surfaced on one side, and two edges, with a calking joint along

each side. The idea in purchasing this lumber in the preceding year was that it could be thoroughly seasoned before being used in the flume. The lumber used for the clamps or frame of the flume is rough redwood of a No. 1 quality. This would probably be designated today as select lumber. The lumber used for the blocking is rough redwood No. 2 quality, and the tops are rough redwood, designated as mill run.

Questioned by Master.

5375 By the top, I mean on the top of the flume. The lumber used was subjected to a rigid inspection when delivered. The method of building flumes—the grade is rough within 2 to 4 inches of the true grade, depending upon conditions. If lumber is to be hauled over grade, as was done in San Mateo Creek, 4 inches should be allowed, so as not to disturb the ground of the true grade. After lumber has been delivered along the grade, the sub-grading is completed to within half an inch of the true grade, care being taken not to get below grade. Then the foreman lines up the flume by driving stakes at the intersection of each section, whether it be a 4 foot, 8 foot, 12 foot, or 20 foot section, after which the blocking for the fills is placed opposite each stake. These fills are laid to grade and placed so that the joints of the sections will intersect on the center of the fills. Then the intermediate fills are spaced and laid to grade. This work is accomplished by the use of a straight edge placed on intersecting fills to give them a uniform grade. When the bottom plank is laid on the short side of the flume, it is used, making sure that the intersecting fills are placed exactly at right angles to this plank before nailing. The balance of the flooring of the section is then cut and clamped by using heavy wooden clamps with harwood wedges, forcing the boards up tight, and then they are nailed. The bottom side boards are then fitted and nailed in place, after which the posts are fitted and nailed in place. The remaining side boards are then fitted, clamped and nailed in place. After this the flume is cleaned and ready for calking or tarring, but before tarring, the inside and outside battens are placed. After tarring, caps and battens between posts are fitted in place. The tops are then fitted and placed.

5376 These notes on flumes were introduced and marked "Plaintiff's Exhibit 109".

Referring to several pages: Page C-2 refers to the actual time of labor, and resultant cost from application of 1913 prices, exclusive of overhead and interest, to the calking of flumes. That is covering the four structures that are referred to there. E-4 is cost of grading Stone Dam aqueduct flume in 1898 with 1913 hours and wages applied. The solid rock is at $1.50 a cubic yard. Loose rock
5377 at $1 a cubic yard, and earth 46.6 cents a cubic yard. I assumed the solid rock and loose rock figures. From the data as given above,

the total cost of this grading is $22,178.37. The segregation is my own, and is for labor only. I do not know what the material cost for grading was. F-2 is Pilarcitos side flume. The figures under the number of days there are the number of days taken from my records of 1909 and 1910, and resulted costs from application of 1913 labor prices. I followed the same scheme that I did in my previous exhibit. The next page is a continuation of that.

F-4 is the labor cost of the Pilarcitos side flume, 1909 and 1910. The advance there is 9.2 percent in 1913, over 1909 and 1910. F-5 is the Pilarcitos aqueduct labor costs of building 2,135 feet of 3 x 5 flume, October and November, 1902. The item "less costs removing old flume" was the cost that I obtained from data for removing old flume. This flume replaced the old flume, which it was necessary 5378
to remove. F-6 is the Pilarcitos aqueduct flume from sand-box at the end of 3x5 flume to San Andres Reservoir, rebuilt in 1904. Referring to the next page, item "base price f.o.b. Millbrae, (L-1)"; the meaning of the brackets with the letter and figure inside of them refers to another part of this same exhibit. In other words, to get the figures which appear you turn to L-1 in this exhibit. F-7 covers labor cost. F-8 is the Stone Dam feeder flume, showing the actual time and resultant cost from application of 1913 labor prices. F19 is the Stone Dam aqueduct between the Stone Dam and Tunnel No. 1. F-11 is for the outlet of inverted syphon to San Andres Dam. That was constructed in 1898. F-12 refers to the Crystal Springs Pump Works. This does not include all of that flume; only a portion of it was built at that time, but the same prices were applied to it all. F-12, 13, 14 and 15 all go together. Referring to F-14; item "boarded 2,256¼ day at 70 cents" that is the board of 5379
the main labor on that work paid by the company.

Questioned by Mr. Searls.

On F-15 I have given the cost of a portion of that flume which will appear later on; it was applied to all of it. It was not all built at one time.

Mr. Metcalf: The cost is on the previous page. F-14, $8,209.21, as against $9,057.82.

SEVENTY-FIFTH HEARING. DECEMBER 8, 1915.

Witnesses: G. A. ELLIOTT for Plaintiff.
ALLEN HAZEN for Plaintiff.
JOSEPH BARLOW LIPPINCOTT for Plaintiff.

(Certain corrections noted in the transcript.)

DIRECT EXAMINATION BY MR. MCCUTCHEN.

5381 I am the engineer of the Spring Valley Water Co., and have been
5382 a civil engineer for 11 years. I am a graduate of the Engineering Department of the University of Colorado, and am a member of the American Society of Civil Engineers, and of the American Waterworks Association. I graduated in 1904, and am 35 years of age. In 1904 and 1905 I was with the General Electric Co., at Schenectady. In 1905 and 1906 I was transit man on power line surveys in New Mexico. I worked under Mr. F. G. Baum at that time, who was afterwards an engineer for the Pacific Gas and Electric Co. From 1906 to 1908 I was field engineer, first for the California Gas & Electric Co., and afterwards with the Pacific Gas & Electric Co., and was assistant superintendent of transmission line construction for the Pacific Gas & Electric Co. In 1908 and 1909 I was superintendent
5383 of construction of 150 miles of steel tower transmission lines for the Great Western Power Co., at a cost of about $1,000,000. From 1909 to 1914 I was superintendent of operations and maintenance of the Spring Valley Water Co., in charge of the construction, operation and maintenance of the city system. Since 1914 to date I was engineer of the Spring Valley Water Co., in charge of the engineering department, construction of the Calaveras Dam, and the construction, operation and maintenance of the city department. I have made a valuation of the waterworks for the City of Burlingame, and was a member of the Board of Arbitration that fixed the price for the sale of those works. With Mr. Herrmann, I made a valuation of the San Jose Water Co., and testified before the Railroad Commission in the matter of fixing rates for San Jose and Los Gatos.

At the Calaveras Dam since last March we have operated one steam shovel for the entire time, and two for a part of the time. In order to make an estimate as to the probable cost of the work, I visited work being carried on by Mr. Mulholland, near Los Angeles, the San Fernando Dam, and the Upper Franklin Dam. My idea was to get some idea of the performance of a steam shovel, on which to base an estimate of probable cost for that work in Calaveras.

Questioned by Mr. Searls.

My notes, made at that time, showed that at the San Fernando Dam the steam shovel was delivering to the wagon 350 wagon loads

per day; at the Upper Franklin, 450 wagon loads per day. I put this in wagon loads advisedly, because it depends upon the material as to what the wagon will hold. With that estimate before me I made an estimate as to Calaveras of about 43 cents per yard in the dam, which is now turning out to be in actual cost about 54 cents. In the last month I visited Los Angeles to check up the steam shovel performance to the present time, and found they were working on the lower Franklin Dam as well as on the San Fernando Dam. At the Lower Franklin Dam for the period from August 20 to November 30 inclusive, there has elapsed 87 steam shovel days; that is eliminating Sundays and holidays; during that time they have moved 43,952 wagon loads, which gives an average wagon load per day during that lapsed time of 502. The maximum per day was 735, and the minimum 162. The shovel was a Marion, model 40, with a 1¼ yard bucket. They were putting 2 dipper fulls to each wagon. 5384

At the San Fernando Dam they had a Marion, model 60, with a 1½ yard dipper and they put one dipper in each wagon, which did not fill it. The period was the same as for the Lower Franklin. On account of working two shifts there were 142 days; the total wagon loads handled was 82,244, giving an average per day of 580. The maximum wagon loads per day 1150 and the minimum wagon loads per day 121. I do not know the reason for the minimum being so small in this particular case, but it was due to interruptions of some sort. They do not make a record of slight interruptions. 5385

The material on which these Los Angeles steam shovels were working was clay shale. It is rather finely divided, requires no shooting, and cut very readily. The bank was about 75 feet high, and does not cave in on the shovel at all, a condition that is rather conducive to continuous work. There is not any particular advantage in the 75 feet; if you have a wall 15 or 20 feet you are just as well off as if you have one 75 feet, particularly if the moving is good. The only advantage in the extra high wall is that you do not have to move the shovel so often to get material, and that helps in a long day's run, as you get more wagon loads. A high bank in some cases is a disadvantage; if it happens to be a loose rock bank, there is great danger of boulders rolling down on the shovel. The bank conditions on the San Fernando and the Lower Franklin were ideal. A shovel could not work to advantage in a bank only 5 or 6 feet in height. You would be bound to lose some on account of the dipper being in a horizontal position when it was being filled. It doesn't get a good chance to scoop it up if the bank is only that high. 5386

An ideal bank depends on the material. For instance, if you had broken rock from a cubic foot to a cubic yard in size, a bank 20 feet high would be better, because there would not be the danger of the rocks coming down and disabling the steam shovel. At Calaveras, where we have an unusually high bank, large rocks came down and hit

the boiler on the steam shovel, and put it out of business for something like 12 days. If you get material such as I saw them working in at San Fernando, a high bank is a distinct advantage, so long as the material will stand in the bank, because you do not have to move the steam shovel so often.

DIRECT EXAMINATION BY MR. MCCUTCHEN.

It is hard to compare the conditions at San Fernando and Upper Franklin with those at Calaveras. Calaveras is probably as difficult steam shoveling as I have ever seen, whereas, those in Los Angeles are almost ideal. The costs at Calaveras were larger than I had anticipated, and the difference is approximately as between 43 and 54. In doing the work at Calaveras, we have consulted with Mr. Mulholland frequently, and not only with Mr. Mulholland, but other engineers and successful contractors have been invited up there by me to show me how to do the work cheaply. Mr. Mulholland wrote me before he had seen the work, and said that it seemed a little expensive, and I asked him to come up and look it over and suggest some way of making it cheaper. After spending practically an entire day out there, he said he didn't know of any other way of doing it, and my recollection is that he said at that time—which was some eight months ago—to
5388 keep on doing the work in the same way. He has been there since on an average of once a month for a day or two, and we are practically doing that work with the aid of his advice.

5389 I know in a general way the conditions that prevail at Pilarcitos and San Andres, and I feel sufficiently familiar with those conditions to state that it is my opinion that a steam shovel would not perform as successfully there as the steam shovel did perform on the San Fernando and Franklin Canyon Dam.

Questioned by Master.

The conditions are not comparable for the reason that the material differs. The San Fernando is being built with a clay core, but without any selection of materials other than hydraulic selection. I do
5390 not intend that Pilarcitos should be built that way. Using a clay core at Pilarcitos, you might put it in dry as it was, and not being so careful of the outside material, you would probably work your steam shovel in one or two locations up there; as soon as you went into the bank you would strike the broken rock. I cannot say to what extent the broken rock would be met with, except that I do know it is in there, and in that respect your conditions would be somewhat comparable to the Calaveras work at the present time. If you built it by using selected clay core—the way in which it was built—and the selected materials for the outside slopes, you would have to move your steam shovel around to a great many places, and a good deal of your cost would come from moving shovel. The location of the pits that have been taken there as the ones which the material came from

would not present the high banks which you should have to get efficient use of the steam shovel. I have been speaking now of Pilarcitos, and my answer would be the same with respect to San Andres, although it is my opinion that San Andres would offer better facilities for steam shovel work; just how much better, I do not know. I have not looked at San Andres with that in view, but I have at Pilarcitos.

My reason for getting these performances in wagon loads was that there is always a great deal of confusion as to how much the output of a steam shovel is in yards; it depends entirely on the material. If you have a very finely divided loam or sand, and you get a full dipper full, or fill up a 2 yard wagon, you get 2 yards, or very close to it. If you have rock, you get very much less. At Calaveras we have a 1¼ yard dipper, and we try to fill it twice for each wagon load; we call that a yard and a quarter in the dam, whereas, theoretically, we are getting 2½ yards. Our measurements show it compacts to 1¼ yard, on account of the coarseness of the material, the great number of voids, and the irregularities of it. At Los Angeles the material they were running on the days I was there was dry shale and clay, broken up into lumps from as big as marbles, to maybe a foot, and even though you filled a wagon with that material, a great number of voids are in it. The voids and the gravel runs 25 to 30 percent when in place. In figuring yards from wagon loads, considerable allowance should be made for the voids, because in the dam the material is compacted. On the San Fernando Dam I got an opinion from three of the superintendents as to how much a dipper full was; one of them said they got a full yard and a half to the dipper; another said that it was 1¼ yards, and I then asked the superintendent, and he said he thought it was a yard. Now, depending on which of those men you talked to, you will get different yardages from that steam shovel in a day. 5391 5392

Referring to 6 photographs; No. 1 is a photograph showing the present location of the steam shovel on the Lower Franklin Dam on the Los Angeles work. It shows the shovel at the foot of a bank between 30 and 40 feet high, and also shows the bank where it has worked along. It shows the general character of the bank, and also the haul they have from the shovel. No. 2 is a general view of the Lower Franklin Dam. No. 3 is a general view of the up-stream slope of the Lower Franklin Dam. No. 4 shows some more of the bank at the Lower Franklin Dam, and also the location to which the material is hauled. This material is shoveled and hauled in wagons to mud pumps, and then dumped into the dam to avoid the long haul. No. 5 is a view taken from the San Fernando Dam to the quarry where the steam shovel is working. It shows the bank, and also the sluicing outfit. No. 6 shows the same view from a slightly different location.

These photographs were marked "Plaintiff's Exhibit 110". 5393

CROSS EXAMINATION BY MR. SEARLS.

Prior to the time I came to the Spring Valley Water Co. I did not have any experience in handling steam shovels. During the years 1909 to 1914, when I was superintendent of operations and maintenance, my work was confined practically entirely to the city system. My experience with steam shovels is limited to the last year. I have had no actual experience in handling a steam shovel, except at Calaveras. We started to expedite the work at Calaveras before July of this
5394 year. The work started in 1913, and the first year we had between 600 and 700 men working clear up to the end of the year; we put in the conduit, and got the upper and lower toes in place.

The dam was commenced, I think, about June 1, 1913. It was absolutely necessary by the time the rainy season came on to have the storm water conduit in place, and the upper and lower toe in place, and the center cut cleared out, because the storm waters would have seriously damaged any work we had in there if we did not have all of that finished by that time. We put on a crew large enough to do that work, and finished it; that was one unit of the work. The next unit was to begin the hydraulic fill, which was commenced probably in January, 1914. The pumps and the motors were bought, and a sluicing unit installed. The work was carried on with one sluicing unit up until the beginning of this year; that was for the entire year
5395 of 1914. Then when we expedited the work this year, we put in two sluicing units, and put night shifts on both of them, and put on steam shovels. I should say that the work in 1914 was being prosecuted with somewhat less than half the rapidity with which it is being done at the present time.

Questioned by Mr. Dockweiler.

In order to get sufficient coarse material it was necessary to use a steam shovel.

CROSS EXAMINATION BY MR. SEARLS.

We tried to get as coarse material as possible with our steam shovel, and we get a large number of voids in our dipper loads as a consequence, and that is why we make that big allowance. A wagon load makes a yard and a quarter in the dam. If I were going to build the Pilarcitos or San Andres dams with a steam shovel, I would not use all the material that I came across; it depends on which way you build it. If you wanted to put the clay core in, and not be particular about your outside slopes, you would open up a quarry, and stay by that quarry, no matter what you came to, unless it was material that you could not work with a steam shovel. Of course the cost of opening up a quarry with a steam shovel is very high, and it takes quite awhile to do the work.

If you were building a dam in which you used the coarse material
5396 on one side, and the fine material on the other, it would be a physical

impossibility, when you were working in one pit, before the first wagon come along with the coarse material, and then if you found some fine material, to take the next wagon and have it directed out of the way. When you try to get fine selected material, you are not looking for anything but some sort of a clay—you are probably thinking fine rock should be mixed in with your clay, and all that sort of thing; you couldn't use it that way at all; you would either have to adopt one method or the other. The dipper takes it all in because it cuts up the bank, and you would have to have two shovels and two pits to do that sort of thing, taking one material for the fine, and the other material for the coarse. I do not think you could build Pilarcitos Dam with the material, from which it was built, from a steam shovel at all economically. If you were going to build that, you would have to use scrapers, and it does not cost as much to move the scraper outfit around as it does the shovel. As far as cost of reproducing Pilarcitos is concerned, I have made no estimate on that at all. I think it would be more costly to steam shovel that material than the material they have at San Fernando, and it would be more comparable with the Calaveras job. I do not see how it would be absolutely comparable with the Calaveras, for, while I know that Pilarcitos has broken rock in there, the pit might not open up so badly as at Calaveras. There are a lot of things that enter into that. 5397

In general, coarse material is material that is not clay. The toes are built out of that material; the clay goes to the center. At Calaveras, from all the pits from which we are sluicing, we have a little more clay than we need. Theoretically, if we had 30% clay, and 60% coarse material, we would have an ideal mixture, because the 60% would form the two toes, and the 30% would form the impervious core. I would a little sooner have some gravel there, because it would be a little easier to handle in the shovel. We are getting broken rock, with clay and shale mixed in it. I would not expect to get much less cubic yardage of dirt compacted in the dam at Calaveras than I would get at Pilarcitos if I used a steam shovel; it is all speculation, as far as Pilarcitos is concerned. The dam was not built in that way, and the quarries that would have to be used in that case had not been opened up, but I do not think it would differ very much at Pilarcitos from Calaveras. You could not build the Calaveras Dam entirely out of coarse material; you would have to use some fine material. I do not think you could use a steam shovel at all in reproducing the Pilarcitos Dam. If you could use a steam shovel, when you came to the fine material that is in the dam, you would get a greater proportion of compacted earth to the wagon load than you could get at Calaveras. I have never examined the borrow pits from which the material was actually taken at Pilarcitos. I have seen them just from standing on the dam and having them pointed out to me. I have never made any particular examination at Pilarcitos with ref- 5398 5399

erence to the building of the Pilarcitos Dam, excepting in a general way, from my knowledge gained in going over there so often in the last 6 or 7 years. I do not know how many pits there were from which the material for the embankments was taken.

(Mr. Dockweiler stated that there were two pits, and that Mr. Ebright was his source of information as to that.)

If there were only 2 pits, it would mean that if you built it by steam shovel, you would only have to work against those two pits; one
5401 probably to get your coarse material, and the other your finer stuff.

Questioned by Mr. McCutchen.

I suppose I have been to Pilarcitos 50 times.

5401-5404 (Discussion on the question of admissibility of hearsay evidence.)

CROSS EXAMINATION BY MR. SEARLS.

I spent half a day at the San Fernando Dam, and about the same time at the Upper Franklin on my last visit. I had been there probably 8 or 9 times before. That was the point at which I made my
5405 preliminary survey before going to work on the Calaveras. The only information that I have as to the cubic yardage handled by the steam shovels at those Los Angeles dams is information that was given me by the men there. The information they gave me is not the result of any measurement in the dam, but is just their idea of what is in the wagons. I have no basis upon which I could compute those wagon loads in cubic yards. They made no measurements of the amounts in the dam. They are using a couple of methods, and it is pretty hard for them to do it; they are pumping some material, and they never will know just what went in by the steam shovel, except by wagon loads. They kept no record as to the causes of interruption to the steam shovel, but it is perfectly apparent, from looking over the records kept by the foreman on the job, that they must have only worked some days a quarter of a day, and other days half a day; you could tell that by the load. I would ask them why, but they could not remember what happened just on those particular days. During the
5406 shovel days there were days when they laid off the entire day. The only thing they saved there is by putting the teams on other work, as they pay the shovel men by the month. This work is being done by the Water Department of the City of Los Angeles, and not by contract. I have heard that a city does not do work as efficiently as a private contractor, but I have also heard it said that the Los Angeles aqueduct stands out as a perfect model of efficiency. I have heard engi-
5407 neers say that, and I have also heard engineers say that it was not.

I made practically no study of the San Andres formation, and it might be easier than the formation either at Pilarcitos or at Calaveras.

Witness: ALLEN HAZEN for Plaintiff.

DIRECT EXAMINATION BY MR. GREENE.

Memoranda regarding concrete, brick work, and excavation, admitted and marked "Plaintiff's Exhibit 111".

This does not include the excavation, concrete and brick work in tunnels, or the excavation for pipe trenches; it does include the excavation for the dams and flumes.

The excavation amounts to 1,119,000 cubic yards, and it has been estimated by the different items all through the schedules at the prices that I believe to be fair for each item considered by itself. The aggregate amount is 811,000, amounting to 73 cents per cubic yard. That includes earth, loose rock, and rock. The amounts for the separate items which are found in subsequent pages of this schedule, beginning on page 17, range from 20 cents a cubic yard for very easy ditch work to $6 per cubic yard for very difficult shaft excavation. One of the largest items of excavation is for the Sunol galleries, and as this excavation presents some rather unusual difficulties, I have referred to page 25 here, as it is fully stated on that page. There are 5409
219,579 cubic yards of concrete in the system which I have estimated according to several items through the schedule, and some of the amount so estimated is 2,097,000, an average of 9.55 per cubic yard for all the concrete in the system, except tunnel lines. In the same way there are 6,034 M. brick, which estimated by items amounts to $184,512, an average of $30.58 per M. laid in the work complete.

To go back to a period not very long before that at which the 5410
Crystal Springs Dam was built, the ordinary method of building a masonry dam was to lay up large pieces of stone in mortar; the mortar was ordinarily natural cement, or, as it was sometimes called, hydraulic lime, and differed from Portland cement in use at the present time. There was 2 ways of laying this masonry. If the stones were cut to dimension, and laid up with regular joints, it was called ashler; if the rough stones were put in with a large amount of mortar for the bed, it was called rubble. The old dams were commonly built by rubble, with a facing of ashler, and that construction is represented in the Spring Valley System by the Niles Dam, which I have estimated as concrete, although really it is not concrete. Generally speaking, concrete is not a more economical material than rubble, and the tendency to replace rubble with concrete was not very strong. What actually happened about the time that Portland cement became common, was a change in the method of building rubble, and a new kind of masonry was developed, which came to be called cyclopean masonry. In this Portland cement, concrete took the place of the mortar in the old rubble masonry, and the soft, unset concrete being a relatively cheap material, it was used freely in large quantities, and the care of setting the stones was reduced, and the proportion of filling to the stones

was increased, and the whole product considerably cheapened. Then developments made a radical change in the whole business of building masonry dams, and nearly all the large masonry dams that I have known of—and I have known about a large proportion of those built in this country in the last 10 or 15 years—have been built by this method
5411 of cyclopean masonry. To build dams by this method, it is necessary that quarries be at hand to furnish good, hard stone for construction. Such quarries have been available at nearly all the large dams that have been built, but there were no such quarries on the Peninsula; the rock is too soft to be used in this way, and therefore, this method of construction cannot be applied on the Peninsula.

There is no sand for making concrete available on the Peninsula; it has to be brought from outside. When the Crystal Springs Dam was built, it came by boat to San Mateo, and was hauled up to the site of the work; at the present time, I suppose, it would most economically come from Niles, over the Dumbarton Cut-off, and be delivered by train at San Mateo, and then be hauled to the site of the work. Sand is a very important ingredient in a dam, and the fact that there is no sand available on the ground makes a substantial difference in the cost of the work in comparing it with other dams.

A third point of great importance is that the Crystal Springs Dam is over 4 miles from the nearest point on the railroad; the country between the railroad and it is developed in such a way that it does not seem feasible to get the right of way to build a construction railroad to the dam. All the materials used would have to be hauled, and that is a matter of a good deal of cost. In comparison with that, every other dam built in the last dozen years that I have known about
5412 has either been directly on a railroad, or has been so situated that a construction road could be easily, and cheaply built to it.

So that there are those three conditions relating to the Crystal Springs Dam; the absence of quarries from which good building stone could be had for making cyclopean masonry; the absence of sand on the site, and the absence of railroads and the chance to build a railroad to the site. Those three conditions are very important. In using the cost of other dams, they have to be kept in mind.

In making this estimate, three lines of evidence are considered:

A: The cost of the material, and the labor required to build the dam now.

B: A consideration of the contract prices of recent large masonry dams built, with allowances for known differences in conditions of labor, supplies, etc.

C: The reported actual cost of construction of the dam.

A and B are depended on for this estimate, and C is used as a rough check, and as a matter of considerable independent interest.

5413 First, I consider the hauling. About 18,000 tons of material has to be hauled. A 5-ton truck would need to make 23,500 trips, or to

run 200,000 miles. Assuming that a truck can make 4 round trips per day, for 300 days, equal to 1200 trips per year, for a period of construction of 3 years, 3600 round trips would be the maximum, and 7 trucks would be required to get the material out in 3 years. The roads would be often soft, so that it would require at least 10 trucks for the service. That is not based on the present excellent road for a part of the distance, but rather on the conditions as they have been through the period under consideration. It is assumed that with an uphill road, a rate of 25 cents per ton mile can be obtained, including the cost of the trucks worn out in the service. At this rate, the amount of the direct hauling would be $124,000.

The roads would have to be maintained, because this traffic would wear them out, and the people would require a contribution in some form to the fund for maintaining the roads. That has always been our experience. I have added 5 cents per ton mile, amounting to $25,000 for road work, which amounts to $6,000 per mile of road. That brings the total cost of hauling the materials to 30 cents per ton mile.

Referring to cement; I went through the purchases of cement by the Spring Valley Co. from 1909 to 1914. That includes the Calaveras purchases. 5414 The prices amounted to $2.13 per barrel. That is not correct, actually, as I found by subsequent information. In reaching the $2.13, I took off 9/10ths of the allowance for bags on the supposition that 9 bags out of 10 would be returned, and that a rebate would be realized on it. That is based on my experience with cement bags in the East, but I find that the cement bags used locally are not as strong as that, and the percentage that can be returned, and on which the rebate is obtained, is considerably smaller, so I am too low on the Spring Valley's actual experience, by several cents a barrel. This is domestic cement. The cement actually used in the dam was imported cement, and I think largely English, with perhaps some German. I assumed a price of $2 per barrel, which is less than the actual cost that has been paid by the Spring Valley Water Co. I did that on the assumption that with a purchase of that magnitude there might be some competition, and the price might be shaded. The hauling to the work would cost 24 cents per barrel, and so I took the cost of the cement delivered on the work as $2.24. Under severe competition—referring particularly to the East—the price of cement has been greatly reduced in recent years, and methods of manufacture have been cut, and there is reason to believe that the cement turned out in the last few years has not been up to the standard that was formerly used. I suggest that, because it is quite possible that here in California, 5415 also, if under competition an unusually low price for cement should be made, it might also follow that cement of the same quality might not be obtained.

The cement used was imported, and had the advantage of long storage before use. Years ago it was required that Portland cement

was stored or aged always before it was used. With cement it is stored so as to allow certain chemical changes to take place that take place very slowly. In the old specifications it is very common to find that no cement shall be used until it has reached a certain age. That has not been required in recent practice, and is one element in the quality of cement. I think we may return to the old practice of requiring storage.

Sand: I assume the sand will come from Niles, and be delivered by rail. The cost of the sand loaded at Niles is taken at 60 cents per ton. This includes excavating, screening, washing and loading on cars, and the amount that must be paid for the use of such pit or land from which the sand is obtained. Freight from Niles to San Mateo is 25 cents per ton, but it is to be noted that sand is usually weighed wet, and the freight bills on wet sand frequently overrun expectations. Cost f.o.b. San Mateo, 85 cents per ton.

At San Mateo it would be necessary to build a trestle, on which the sand cars could be run, with bins underneath, and with some arrangement for handling the sand to the motor trucks to be used to carry it to the site of the work. 15 cents per ton, a total of $8100, is allowed for the installation and operation of this equipment, and this includes the whole cost of unloading the sand from the cars and
5416 putting it on the trucks. The hauling from San Mateo to the dam at 30 cents a ton mile, including road repairs, amounts to $1.25 a ton. Total cost of sand per ton at dam—$2.26. The weight of a cubic yard of sand is about 2600 pounds. Cost per cubic yard $2.94. Practically $3 a cubic yard for the sand on the work.

Ballast: The ballast could be obtained on the ground, or near by. It consist of broken stones, ranging in a general way from ½ inch to 2½ inches in size. My information as to the quarries was received from Mr. Schussler and Mr. Lawrence. I have looked at the quarry, and I think there is no doubt but what large quantities of material were taken from it. My estimate is made on the theory that the rock
5417 is at hand. It is not a very good quality rock, but it was used in this dam, and it is what I have assumed would be used in reproducing it. Made up as it was used, it makes a thoroughly good dam. From the standpoint of ordinary concrete work, it is not the best kind of concrete ballast. In my judgment, it would be necessary, in operating this quarry, to reject a large amount of soft material. The cost of handling this material which would be discarded is an element in the cost of the ballast per cubic yard, delivered on the work. Taking that into account, I reach 90 cents per ton, equal to $1.25 per cubic yard.

For the cost of the concrete in place, I estimate cement, a barrel and a quarter a cubic yard, at $2.24—$2.80. For sand 1/3 cubic yard, $2.94—97 cents. The sand is somewhat less in amount than would ordinarily be figured. The 1/3 of a cubic yard is not enough to fill up all the void in the ballast. The figure differs from the amount which

I have estimated for sand in other cases, and therefore, I make this explanation at this time. 1 cubic yard of ballast is required, costing $1.25. The total, $5.02 for the bare materials and the concrete on the ground. To this I add for plant equipment and forms, including all the bins, mixers, water supply, roads, tracks, the false work built in the dam to permit the economical distribution of the concrete, all the houses, offices, conveying equipment, and expenses of maintaining 5418
them, renewing them, and changing them during the operation, $2 per cubic yard. That does not include the rock crushing plant.

Questioned by Master.

In this all modern means for making and placing the concrete are used throughout. For the labor of mixing, transporting, placing and ramming the concrete, I allow $1 per cubic yard. To that I add an allowance for management and contractor's profit, if it be done by contract, or for contingencies, and if carried out by day labor by the company, of 98 cents, bringing the total to $9 per cubic yard.

This dam was actually built by separate blocks of concrete, built in place, but so that they fitted into each other. It was certainly one of the first dams ever built in that way, and was the type of a system of joints that has become universal in the best practice at the present time. I have not assumed in this estimate that all of the joints in the original dam would be reproduced, but some of them would be; just how many I have not attempted to say. This dam is within a few hundred feet of the San Andres earthquake fault, and it went through the earthquake of 1906 without injury, and without any cracking of the masonry. The thorough construction, and the fact that the dam was cut up into these blocks, I believe contributed to that result, which is a very wonderful one. 5419

Local Handicap: The total hauling bill will amount to about 90 cents per cubic yard of material, obtained by dividing the product of the 118 tons by 30 cents a mile ton for 4.2 miles, and dividing that by the yardage in the dam. If a branch railroad to the site of the dam were available, a greater part of this could be saved, but from the cost of saving so made the cost of getting the track would have to be deducted. The total bill for hauling is about $150,000, and it is clear that a branch railroad could not be built to the dam site for an amount that would represent a total saving within this figure. The difficulty of a right of way would be one of the obstacles. The cost of construction would be further increased by the lack of a good neighboring quarry of hard rock from which plums could be obtained. Plums is the ordinary term for these large rocks that are used in concrete forming cyclopean masonry. If such a quarry were available, plums costing from $2 to $3 per cubic yard would take the place of material costing $5.02 per cubic yard for the material, and $1 per cubic yard for placing; a total of $6.02 per cubic yard for concrete, exclusive of forms and general expense. The saving would amount to from $3

to $4 per cubic yard of volume occupied by the plums. The proportion of plums that can be used depends upon the way in which the stone from which they are obtained breaks, and the closeness with which they fit. It ordinarily ranges from 20 to 40 percent. An ordinary figure that can be usually reached is 1/3. Using this, if plums were available, the saving of $1 to $1.33 per cubic yard for completed work might be made. I have used $1 in that which follows.

5420 The cost of construction would be further increased by the absence of sand. In most of the large dams that have been built, good building sand was obtained upon the ground, frequently at a cost of not more than 50 cents per cubic yard. Making allowance for handling and washing, the average cost of sand delivered at the masonry, I took at $1 per cubic yard. In this case here is an excess cost of about $2 per cubic yard for the sand. We are using 1/3 of a cubic yard of sand for each cubic yard of finished work, so that the extra cost, because of the absence of sand in this case, amounts to 67 cents per cubic yard of finished work. The amount estimated for hauling sand is included in both the sand, and in transportation. It amounts to 50 cents per cubic yard.

Adding those three items up, and deducting the 50 cents per cubic yard, which came into 2 of them, it gives a handicap of $2.07 on the Crystal Springs Dam, as compared with ordinary conditions. I consider in a general way that this work would cost $2 more per cubic yard to build than the ordinary cost of similar work situated as such dams have usually been situate.

5421 The Kensico Dam, the largest dam that I know about, is now approaching completion. A contract was let in 1909. A railroad goes within ¼ of a mile of the site, and branch lines from the railroad went right into the contractor's plant. Building sand was available at the site. A quarry furnishing plums was within a mile or so of the dam, a special railroad being built by the contractor to bring them on to the work. That is part of the New York system of water supply. The contract price for the cyclopean masonry in this dam was $0.41 per cubic yard, an exceedingly low price. In making up these prices on this page, I have taken the total, where more than one kind of masonry was used, and have included the price of cement, which is frequently furnished separately. On the Kensico Dam the contractor furnishes the cement, but the City of New York keeps a record of it, and pays him so much a barrel for that which goes into the construction, and so much a cubic yard for the masonry without the cement; this figure which I have written in is a combination of the two, both in one contract.

5422 The Ashokan Dam, was built by the City of New York, in the Catskill Mountains, by contract, let in 1907, at a time of relatively high prices. The contract returned a very fair profit to the contractor. The year following prices fell off a good deal, and the labor and material

market was lower during most of the construction than it was when the contract was let. This dam was perhaps 2 miles from the main line of the Austin-Delaware Railroad, and it was very easy to build a branch line of railroad on to the dam site. There was a very excellent rock for plums available at the dam site, and quarries were opened that delivered it on a downhill haul to the dam; there was also good building sand in the neighborhood, so conditions for construction were all favorable.

Questioned by Master.

That $2 is for lack of sand, lack of railroad, and lack of plums at the Crystal Springs Dam. The cement here will cost us $2 a barrel, as against $1.25 for this Ashokan Dam, and there will be some other things to take into account. The $2 per cubic yard additional cost to the Crystal Springs Dam relates not to the Ashokan or Kensico Dam, but to a dam near San Francisco as favorably situated as they are. 5423

The Wachussett Dam, built by the City of Boston; the railroad ran directly through the site of this dam, and had to be moved. Cost of moving the railroad was not included in this price for masonry. Good plums were obtained immediately adjacent to the site, and there was an abundance of good building sand. I think the work was let in 1900, possibly a little earlier, but it was at a time when prices were advancing, and they continued to advance during the construction of the work, and for some time afterwards. That price, a low price at the time, is one that could not have been duplicated since 1907.

The Cross River Dam, built by the City of New York, as a part of the Croton system. Contract let in 1905. This dam is about a mile from the Holland road, one of the main lines of the New York Central, and a branch road was built from it directly on to the site of the dam. Good building sand and plums were available in the immediate neighborhood. The contract price yielded a fair return to the contractor. These four dams I think are particularly appropriate as giving an idea on the recent cost of large dams, and I have used them particularly in that way. 5424

A dam at Hartford, Connecticut, was built on a site which I originally selected, and for which I made an outline plan, but it was built by another engineer. The contract was let in 1914. The dam was half a mile from the railroad, and good building sand, and good plums were available in the immediate neighborhood. This is an abnormally low price. 1913 was a year when work was scarce, and contractors were looking for work to keep their equipment going.

A dam at Columbus, Ohio, a little distance from the railroad. Good plums and good building sand were available on the site.

A dam at Loch Raven, a part of the Baltimore water supply,

was let in 1912, was quite near the main line of the Pennsylvania Railroad, and good sand and plums were available.

A dam at Pittsfield, Mass., contract let in 1910. I do not know its relation to the railroad. Good sand and good plums were available.

Alexandria, Va.; this item was put in by one of my partners, and I have no personal information in regard to it. It is a small dam, for which a contract was let in 1913.

A dam at Springfield, Mass. The only dam which I have been directly responsible for. Contract was let in 1908; good sand and good plums were available, but it was quite a long distance from the railroad, and the cement, and some of the other supplies had to be brought in. The lumber was obtained on the ground, as there was
5425 good standing timber which we permitted the contractor to use without cost. The contractor did not carry this contract through, and we took the work over and finished it at his expense. I think that the price was perhaps a normal one for that work, nevertheless.

A dam at Holyoke, Mass.; built as part of the water supply, where there was good sand and good plums, but several miles from the railroad, and the contractor was unable to finish that work, the price being too low. I put, finally, for comparison, the Crystal Springs Dam, 4.2 miles from the railroad, without plums and sand, 163,000 cubic yards, so that the first three dams that I mentioned in this list are larger than it, and the others are smaller. For the eastern dams, in using this data, I assumed that the average price of labor near the work was applied.

Questioned by Mr. Searls.

The Kensico and Ashokan Dams were built in the City of New York. I have acted, and am acting as the consulting engineer to the department that built these dams, and my duties have not extended to the construction of the masonry. They have taken me on to the site of the works repeatedly during the construction, and I have had official relations with the chief engineers, and the resident engineers who have built them, and have had every opportunity for finding out everything that I wanted to know about them. The Wachussett Dam was built by the City of Boston, and I had some-
5426 what similar relations there. I was on the work frequently during construction, but my official duties did not extend to the actual construction of the masonry. The Cross River Dam was built by the old Croton Aqueduct, which I also advised in regard to some matters, and saw the work repeatedly during construction, and had access to the records. I selected the site, and made the preliminary study for the Hartford Dam. The Columbus I saw during construction, but have no official connection with it. These are the contract prices, and are not to be taken as the cost of the finished work. The Loch Raven Dam was built by the City of Baltimore, and I advised

the Baltimore Water Department as to various matters, and was familiar with the site of the work and the conditions, but I did not advise them with regard to the construction of the masonry. On the next two items my information is second-hand. The Springfield Dam was built under our own construction. The Hollyoke Dam I had to do with officially in an advisory capacity.

Questioned by Mr. Dillman.

These prices did not include anything besides masonry.

Questioned by Mr. Searls.

The specifications of the masonry differed considerably in the various dams. With the exception of the Virginia Dam, every one 5427
of these dams was of cyclopean masonry.

Questioned by Mr. Dillman.

Crushed rock would predominate in the ballast, but a good deal of gravel was used in some of them. In trying to make use of this data for California conditions, I have tried to size up the differences as well as I could, and apply them, and for that purpose I took the average price of labor on these works when they were built at about 20 cents per hour, on a number of them it was less than this figure. On the Wachussett Dam approximately 15 cents per hour was paid at the start, and it was increased as the work proceeded. Full information would probably show it to be a little less, between 18 and 20. It would be distinctly higher in 1915, and with casualty liabilities would now be between 22 and 25 cents.

Questioned by Mr. Greene.

There has been an increase from 1913 to 1915, mostly due to the more stringent laws that have been passed.

The cost of the cement, delivered at a convenient siding near the eastern dams, ranges from $1.25 to $1.50 per barrel, probably averaging $1.35 for all of it. To explain the difference between the prices of cement in the East and out here, for the Eastern market 5428
the cement is made in the Lehigh Valley, and in New Jersey, and in the Hudson River, and for the San Francisco market it is made by three mills within 100 miles of San Francisco, and I presume the cost of manufacturing is greater here than it is in the East. I should think that was the primary reason for the difference. I could not tell you what the cost is to manufacture a barrel of cement in the East.

Mr. Dockweiler: I can tell you, it costs about 68 cents a barrel, after depreciation charge has been met, f. o. b. the cars at the factory here in California.

Mr. Hazen: In comparison with these for the Crystal Springs Dam I assumed an ordinary cost of labor of about 30 cents per hour, which is about 50% more, and the ordinary cost of cement f. o. b. cars Millbrae about $2 per barrel, which is 48% more than the $1.35 approximately going prices on the Eastern work that I have re-

ferred to. Those are the two largest items in the dam cost. We
5429 have the labor 50% more, and the cement 48% more.

Mr. Dockweiler: The plant where the cement is made for 68 cents a barrel is at Oro Grande, owned by Mr. Leonard, which is being built at the present time. They operated a duplicated plant in El Paso, Texas. That does not give you any idea of what they are going to sell it for. I am telling you what it costs to manufacture cement after making the depreciation charge. I know that, because I have seen the books. I saw the charges that he had made, and the plant that is going to be erected is an exact duplicate of the one he
5430 is operating now. That includes office charges and everything.

Mr. Hazen: The average contract price for the Eastern dams of recent construction for the four largest dams above 100,000 cubic yards each, is $5.45, and for all of the eleven of them in the above record, $5.45, the same figure. As a rough approximation I took this $5.45 and took the labor and cement ratio, which happened to be practically the same, as an indication of the whole probable cost ratio, and multiplied this $5.45 by $1.49, which gives $8.12 as the probable cost of constructing a dam in California, under conditions as favorable relatively as those represented by the first four dams in the list. Adding to that the handicap for lack of railroad, sand and quarry, $2 gives a corresponding estimate of $10.12 per cubic yard. Then I made another comparison, which I think is a better
5431 one. The average contract price on the four large Eastern dams was $5.45. Adding the handicap for lack of railroads, sand and quarry, at the Crystal Springs Dam, $2, with a corresponding price for direct comparison of $7.45. To that I add the increased cost of cement $2 per barrel instead of $1.35, or 65 cents per barrel, and the quantity used is practically 1¼ barrel per cubic yard, so the increased cost of cement is 81 cents, and adding that brings it to $8.26. To that I add for increase in the labor cost, taking it very roughly at $1.50 per cubic yard for Eastern conditions, and 50% increase for California, would be 75 cents to be added. The total allowance for increased cost of cement and of labor is $9.01, and then there should be added to that 10% for profit on the $3.55, the sum of the additions to this point, or 35 cents, making a total comparative cost of $9.36 per cubic yard. I used the first four Eastern dams there, and also the whole eleven.

5432 The Spaulding Dam is a dam of similar size to the Crystal Springs Dam, recently built in California, and I made some inquiries in regard to that, and visited it, but I do not think the conditions are comparable so that this could be used as a direct basis for comparison, but in a general way it is somewhat comparable, and I have included it. The conditions in the Sierras are more like the Eastern conditions. They have hard rock, and the sand and the gravel on the ground, and they are not subject to what I have called the

local handicap on the Crystal Springs Dam. This was in part cyclopean masonry, but they wanted to build it very rapidly, and did not have the time to put in as many plums as they might have done. Their gravel was brought in about 30 miles from an old pit, where hydraulic mining had been carried on, and where the gravel was piled up in shape for direct use. They loaded it very cheaply, and had simply the 30 mile haul on the railroad, so that it was a very favorable condition. The sand came from the same place. They paid $2.15 for cement. 5433

Questioned by Mr. Dillman.

That does not correspond to my price of $2.24 at San Mateo, but I think that would correspond with the $2 at San Mateo, and $2.24 at the Crystal Springs Dam. The indirect construction costs I had from Mr. Vincent, and I did not attempt to audit them. I understood that they included things like the indirect costs on the Los Angeles Aqueduct. This was only part of the work done, and if that was pro-rated, there would be much larger figures.

Questioned by Mr. Searls.

The item of dams and spillways on the Spaulding I took as including the main dam, and two small auxiliary dams through low points in the rim, which they class as spillways. It was my judgment that $9 per cubic yard was a fair estimate of the cost of reproducing this dam during the period from 1907 to 1914. I made an estimate for a dam of just about this size, in Australia, a few years ago, 5434
and I used methods of calculation somewhat similar to this, and thought of everything that I could think of, and based the estimate on that, and added something, and my correspondents tell me that the actual cost was overrunning the estimate.

DIRECT EXAMINATION BY MR. GREENE.

The whole construction account by the Wenzelburger statement, is $2,242,688.92. Details are given for about one-half of this amount. For the remainder no details are given, as the book has been lost. Mr. Sharon concludes that of the total amount there was spent for lands and rights approximately $263,000. He finds, also, that the cost of the Upper Crystal Springs Dam, raised in 1890, included this expenditure listed of $34,041. I made those two deductions, and have a remainder of $1,945,000. From looking through the record, I should say that all the contingencies were included, and 5435
also the engineering and supervision, but that no expenses of preliminary work, or of general administration were included. The records are not in such shape that it is possible to compute from them the prices per cubic yard of masonry. In fact, there are no unit prices in the statement. There are only the items of the payment, and the summary shows the total amount that was paid.

There is no way of classifying these statements so as to get unit prices from them. It is assumed that the work covered by the above statement included the Lower Crystal Springs Dam, the Howard Cut, the Gate Tower and Standpipe, the intake pipes, the outlet tunnel and the bridge. I estimated the cost of reproduction for these structures, without overhead, at $1,746,160. To this is added 15% for engineering, supervision and administration and legal expenses. This classification differs from the record of cost in that the administration is included, while it seems not to have been included in the cost record. There is no sure way of separating the administration and it must also be passed. Adding 15% to these items, $261,000, brings the estimated cost of reproduction, including engineering, supervision and administration, to $2,107,000. This, including ad-
5436 ministration costs, is $62,000, or 3.2%, more than the reputed cost of the work excluding such costs by the Wenzelburger statement.

From the above comparison the original cost of construction was practically the same as the present estimated cost of reproduction.

In connection therewith the following changes in prices may be noted:

(1) The labor cost at the present time is considerably greater than was the actual cost.

(2) The cost of California cement at the present time is very much less than was the actual cost of the imported cement that was used.

(3) The cost of labor and teams for hauling the materials from San Mateo to the dam site were less than would be the corresponding costs at the present time. On the other hand, the use of motor trucks greatly reduces the cost as compared with what it would be if done by the methods originally used.

(4) There have been improvements in machinery and methods for handling work of this kind, and these would result in substantial savings as compared with the methods that were originally used.

To sum up: *On present evidence it appears that all the above tendencies have about equalized and offset each other, and that the estimated cost of building the dam at the present time is practically the same as the actual cost of construction* 25 *years earlier.*

The Crystal Springs Dam is a magnificent piece of masonry construction. After standing exposed to the weather for 25 years, and having gone through the earthquake, it is in as good condition as
5437 could be expected of a dam that was finished last week. There is not a defect in it. It is tight; it is a very creditbale performance. There would be some added cost now in reproducing the dam, if the original joints were duplicated joint for joint, over the estimate that I have made here. The joints, in my judgment, are necessary, but

probably not as many as were used on this dam. Those joints are not cemented together. I do not understand that there is anything between those blocks. Those blocks were made in place. 5438 5439

I looked the country over there for rock that would make plums, and I have not been able to find any. There is granite beyond Pilarcitos, but as far as exposed it is a very soft, inferior granite, that would not be suitable for plums. There is an indication of rejection of rock at the quarry now in operation near the dam. As far as a quarry actually used for this dam is concerned, there is nothing that we could see; it is under water, but there is a quarry down toward San Mateo from Crystal Springs Dam that is now in use, and from looking at it one can see that there is a very large spoil bank running down hill for a long ways where the rejected material has been put out; probably a quarry running in that way, making material for roads, etc., would be very much less critical of the character of the stone than it would be necessary to be in getting stone to build a dam like this, so it seems to me that even for ordinary purposes, the rejection is very large, and to get a stone for a dam, I should expect it to be larger still. I did not exclude the years 1907 and 1908 in regards to the purchase of cement intentionally, but I only asked for carload lots, and I did not think that small purchases would throw any light on it, and I excluded those from consideration. 5440

There 5,297 cubic yards of concrete in the Peninsula System, outside of the Crystal Springs Dam, and the estimated cost of reproducing is $72,717, an average of $13.73 per cubic yard. That represents a great variety of small structures, and in building all of this concrete, it is subject to similar handicaps to those described in connection with the Crystal Springs Dam. 5441

In the Alameda System there are 18,915 cubic yards, the estimated cost of reproducing which was $216,528, an average of $11.45. These structures are somewhat scattered, although there is quite a large amount at Sunol at the galleries. For this concrete, sand and gravel is available nearby, and the cost is considerably less by reason of that fact. It is also near the railroad, and cement and other materials can be delivered near the work without the expensive haul. On page 20, on the Sunol filter gallery, I estimated $10 per cubic yard for the single barrel structures, and $12 a cubic yard for the double-barrel tunnels, which differ from the first in having two channels for water, an upper and a lower, being a much more difficult structure to build than a single-barrel tunnel. I do not know the actual cost of that work. These are my estimates of the fair costs of reproducing the work at the present time. In the city system there are 32,258 cubic yards, to reproduce which I estimated there would be required $340,677, an average of $10.55 per cubic yard. That is in connection with the various reservoir lines, the foundations for the standpipe, etc. It is a lower figure than the one I have 5442

employed in the Peninsula and Alameda work, and the principal reason for that is that most of these items represent a larger yardage at one place, making it possible to use more economical methods of mixing and placing.

On page 13 I have placed a study of relative concrete costs, made up in a general way. There are a great many figures in it that represent roughly my idea as to different situations, and there was no precise way of getting at them, but I made it to compare the estimates that I have made on this system with the actual cost of concrete work which I have built. The method that I have followed is to take the cost of the ingredients of a cubic yard of concrete first.

5443 The first one is the Crystal Springs Dam, and this corresponds, approximately, with the figures that I have already used for that, except that I took the sand at .40 per cubic yard, the ordinary figure, instead of .33, which was the figure actually used. I did that because .40 is the ordinary figure, and the one that was used for all the other items in the comparison. The total estimate is $9 per cubic yard. The materials come to $5.10, and it leaves a difference of $3.90. The labor cost is the largest single element of that difference; there are a great many other things to come in, but I simply divided that by the wages for one hour as a rough index to the estimate; in that case it comes out 12. The labor cost on a massive construction like that is comparatively small. For all the other Peninsula structures, the cost of the concrete came out, as I figured it, $5.62. That is principally because of the extra haul, I think. The haul is greater to these structures than to Crystal Springs Dam, and the estimated cost per cubic yard $13.73, the difference $8.11, which in terms of 1 hours labor is 26. For the Alameda structures the materials cost $4.17, almost $1.50 a yard less than for the Peninsula structures, and made so because of the location; the estimate per yard $11.45, the difference $7.22, equal to 23 times the hourly wage, and for the city structures materials cost $4.25; the average estimate $10.55; the excess $6.30, equal to 20 times the hourly wage. If all of the costs

5444 and profits were resolved into labor, the 12 Crystal Springs, 26 Peninsula structures, 23 Alameda and city, would represent the hours of labor for one laborer on each yard of concrete, but that difference includes labor, and all the materials and all the profits. It is just an index.

In the lower part of the sheet there are corresponding figures for concrete which I have placed myself. At Albany we placed 25,800 cubic yards. The cement cost $1.93. The sand was obtained alonside, we did not buy it. This work was done by contract, and the 30 cents represents my belief as to the cost of the sand on that work. The 50 cents represents the cost of the ballast. The total cost of materials per yard of concrete $2.98. The cost of that concrete under contract was $5.22, the difference $2.24. The average

cost of labor per hour $.14. When the work was let, the going price per labor was between 12 and 13 cents, but it went up and was 15 cents the latter part of the time, so 14 is a close enough approximation for the whole period, and the quotient is 16. At Washington we placed 113,000 yards of concrete; the cement cost $1.40; sand cost 80 cents, and was brought in by rail from a very favorable pit perhaps 15 miles out, and the ballast also came in by rail, and cost approximately $1.50, making the total cost of the materials on the ground $4.42. The cost of the concrete was $7.68; the excess $3.26, 5445
and the approximate price for labor 16 cents an hour, and the quotient was 22. At Peekskill 4,440 cubic yards. That was built in 1909, and I have put the cement in at $1.50, which is more the price of cement f. o. b. This work was done at a place where the delivery of cement was expensive; it was a very hard, uphill haul, and that is a rough approximate figure to represent the added cost because of that. The sand and ballast were secured in the immediate neighborhood, and was cheap, and were put in at 50 and 75 cents, respectively; the total cost of materials was $2.75; the average cost of the work $6.61; the difference $3.86; the average price of labor about 18 cents, and the quotient 21.

On the Little River work for the City of Springfield, in 1909, we placed 40,500 cubic yards of concrete; the cement cost $1.35, approximately f. o. b. cars; the sand and ballast were obtained locally, but perhaps required more cleaning at the works at Peekskill, and I put them in at 50 cents and $1. The total cost of materials $2.78 per cubic yard; cost of work under contract $7.61; the excess was $4.83; the ordinary price of labor about 18 cents, and the quotient 27 cents. In one of the other contracts of this same work, I gave the approximate price of labor as about 20 cents an hour. The concrete work was done at a lower level, and nearer the city, and the Borden Brook Dam was further out. The contractor for the Borden Brook Dam paid a higher rate for labor than the contractor operating near the city.

Yonkers, 5400 cubic yards; the cement cost about $1.35; the 5446
sand was obtained on the site; the ballast from a quarry nearby. The total cost of materials $3.23; the cost of the finished concrete under contract $8.61, a difference of $5.38; 20 cents per hour for labor, and the quotient is 27.

At Toronto, in 1911, I placed 37,700 cubic yards of concrete. The cement was made in Canada, and cost a little more than cement in the United States, about $1.50 a barrel. The sand was obtained in excavation for that work, and cost nothing except handling. The ballast was obtained partly in excavation, but some had to be brought in from the outside. That on the ground cost less than $1 a yard, and that which was brought in cost more; the total cost of the material was about $2.89 per cubic yard; the contract price for the

finished work $7.39; the excess $4.50; labor 20 cents per hour; quotient 23.

Ogdensburg, 1912, 4500 cubic yards of concrete placed. Cement cost $1.50 a barrel, because of the longer railroad haul. The sand had to be hauled some miles, and the cost was $2 per yard because of that. The ballast was obtained on the ground, and was cheap; the total cost of materials was $3.35; cost for finished work $7.75; difference $4.40; labor per hour 20 cents; quotient 22.

Excluding the Crystal Springs Dam, the amount which I estimated for concrete in excess of the estimated cost of materials is from 20 to 26 times the amount paid for one hours labor, and averages 23 times. For 7 Eastern pieces of work, carried out from my
5447 plans, and under my supervision, corresponding differences range from 16 to 27 times the amount paid for 1 hours labor, and averaged 22 times.

The above comparison is on broad, general lines, and cannot be taken as precise. In a general way it indicates that, taking into account the local conditions, the amount estimated for concrete in the Spring Valley System agrees closely with what the cost has actually been on the Eastern works that are mentioned.

5448 On page 14 I have the basis which I used in general in estimating this brick work. It is used as a sort of base cost, and in applying it, considerable variation was made, as the work was more difficult to lay, and more expensive than ordinary straight work. The only items to which supporting data seems to be needed is for "Labor, minor supplies, and contingencies", which I estimated at $15 per thousand; the supporting data on that is the cost of some work done under my direction at Albany, many years ago, the particulars of which are found on succeeding page, for which the corresponding figures obtained from the contract prices, and the costs of the materials which I know, approximately comes out $9 per thousand, as against $15, which I have used in this case.

5449 Questioned by Master.

The 200 pounds of weight opposite that item I have used as a schedule for getting at the cost of hauling, and the increase in cost of work done far away where the hauling was heavy. It does not come in in any other way. This work done at Albany was the largest and cheapest piece of brick work that I ever did. When I commenced to build waterworks structures, brick was the common material for construction for a great many years. The brick were hard, burned brick, from the center of the kiln. The mortar was made from either natural cement and sand, which was used where the work was not to be exposed to the frost, or from imported Portland cement, almost always German in my experience. At that time there was no bricklayers' union, and there was plenty of men who knew how to lay brick and make a perfectly water-tight job, and they

did it economically. It was a very advantageous method of construction.

Quesioned by Mr. Searls.

I cannot tell you how many brick they laid per man per day in those days. At Albany, when we started to work, it was the intention to build it mainly of brick. As we got into the work, it appeared that it would be advantageous to use concrete for the greater part of the work, and that was done, but there were still a great many structures that we thought prudent to use the brick for. Something like 5,000 cubic yards, which would represent 2,500,000 brick, or considerably less than in the whole Spring Valley System, was laid and built of brick. We started in with that work in the same way that brick work had been done, but in the middle of it the bricklayers' 5450
union appeared and tied up the work, and it ended in all the men we had on the work joining the union. The fact that the work became unionized did not add much, if anything, to the cost of the job, but it reduced the quality of the work. In spite of every precaution that we could take, the work leaked, and while the leaks did not interfere with the substantial solidity and usefulness of the work, it was very unsatisfactory in that respect. The concrete walls were free from this leakage. The reason that it leaked is that the brick masons are used to laying brick with lime mortar in walls of buildings, and they want to lay a brick in hydraulic structures in the same way. The union insisted that the mortar should be put on each brick, and that the brick with the mortar should be put down in its position in the wall. That is the way brick is laid in buildings. It was our first experience, and it got by, with the result that the wall leaked. Since that time I have built very little brick work. On one job, where it was away so that the unions did not interfere with us, we built it with some thousand of yards of brick; that work was all done by green Italians and Austrians, under men that I sent out from my office that knew how brick work ought to be laid; under my instructions that work was economically done, and was tight, and if it was not for the unions; if we could have green men lay brick work as we used to do, men that we could teach brick work would be very much more advantageous than it is relatively. 5451

The way that brick ought to be laid is to have your brick wet, and then to be laid with a trowel on either side of the wall, carrying the outside up a little in advance of the middle; into the middle of the wall is to be placed pails full of mortar so as to form a deep bed, and then the man must take these wet bricks and put them down into that mortar without the use of a trowel. If that system is followed, brick work can be done rapidly, economically, and it would be tight, but you cannot get the bricklayers to do it. In our recent experience you have to put an inspector over every bricklayer to make him do it, even though you can get him lined up while you

are watching him, just as soon as you turn your back he will go back to his other methods, so as a practical matter, brick work has almost disappeared; it has been replaced by concrete.

I went through the estimate on the basis which you see, which is one that seems perfectly fair under the circumstances, and I followed that generally, but there are quite a number of structures in the system, some quite large ones that represent a good deal of brick. When I came to them I said I would not build this structure of brick, I would build this of concrete. Where I felt that way about it, I did not use the prices that grow out of the consideration of brick work itself, but used the prices that were the equivalent in concrete, and so, wherever you find in this schedule, $25 and $20 for brick
5452 work per thousand, that means that I think I would replace with concrete, $12.50 or $10 a cubic yard; practically speaking it takes 500 bricks to a cubic yard, and the $25 per thousand for brick corresponds, roughly, with $12.50 to concrete; so I have considered in that way a just price was reached between the two. The price reached would be always lower than the price for brick.

My lowest base cost for brick is $29, and my highest $43. That is simply a matter of haul. If the work was not plain, simple work, I would estimate more than this base wherever it was, because of the extra difficulties in laying brick in the particular form or structure. It is a great deal harder to lay brick with Portland cement than it is in lime mortar, and in specifications of brick laying the number of brick that a man will lay, based on lime mortar is not applicable to Portland cement work. The lime mortar is smoother; it pushes home a good deal easier, and it does not get hold of the man's hands,
5453 so that it is pleasanter working with it. I have always considered brick as an alternate to concrete. If there was any structure that could be more advantageously replaced by brick, I have always taken good brick work laid in Portland cement if you can get men to lay it properly, as equivalent to concrete, and in the specifications that I have drawn I have allowed that option very frequently, but it has been very rarely accepted.

On page 30 is some hearsay evidence from an article in the "Engineering News" in regard to the Spring Valley brick work.
5455 The author of that was Professor Derleth.

Questioned by Master.

Referring to page 25, excavation on the Sunol Galleries; sheeting is the lumber that is put down on either side of the trench, and is braced to hold the sides up while it is being excavated. The word
5456 temple refers to the water temple, the gate house over at Sunol. That was a wooden structure originally, but when it was no longer safe, because of the prospective rotting, the concrete structure was built alongside, and, of course, the wood is rotting and will disappear, and the concrete will be left. That was an advantageous pro-

ceedure for the company, but to reproduce it at this time, it would be necessary to include provision for supporting the sides of the trench while the concrete was being built, which is not included in the schedule. That is what I have done. A further, and very important matter which relates to this, and some of the other structures of the company; at the present time the ground is drained by the structures themselves, and before the structures were built, probably the ground water level was a great deal higher than it is now. That is something that we cannot know certainly about, but from general experience we know it must have been higher before the drains were provided than it is now, and so, in estimating the reproduction, it would not do to base it on the present ground water level, and the present amount of water, after the structure has been in service and has drained it. 5457

Referring to page 68 of witnesses' inventory; excavation, pick and shovel, through gravel $2: The first item 67,299 cubic yards consisted in picking off the surface material to a moderate depth, and was cheap work, but that might possibly be done by a New Era grader. That is put down at 30 cents a cubic yard. After that excavation was made, the next item, 10,721 cubic yards, is a deep, narrow trench, excavated in the bottom of the first excavation, and that would be down below the ground water level, would have to be sheeted, and the water would be very troublesome, and that would be very expensive work, so that I have estimated that at $2 per cubic yard. In structure 2, which I make $3, I think that was a deeper, narrower trench.

Questioned by Mr. Greene.

The excavation for pick and shovel is bound to be below the water level, because these were collecting galleries; if it was not below the water level there would not have been a promise of any water. I have included the timbering that would be necessary in lagging the trench, although it is not there. The lagging would necessarily be gone. 5458

The Master: Even if you allowed for your lumber there, Mr. Hazen, you would not allow for the labor of your lagging in the $3800, or 108,000 feet? A. I have the explanation. This is a note I made at the time on the ground with Mr. Lawrence. This was originally a wooden gallery, and the wooden lagging is part of the original side construction. The wooden gallery was completed about 1900; about ten years later a concrete structure was built, taking out the timbers on the top, and leaving the board sides; some of the timbers were left in the concrete. There is no bottom to this structure. The concrete is very light, and is heavily reinforced by concrete struts, and steel rods from side to side. I think that fully answers it. Apparently this item of 108,000 board feet is some of those side timbers that are actually left over there at the present time. They did not lagg after building 5459

5460 the concrete. I have allowed $3800 for that item, and a little labor cost would be in that.

5461 The Master: $3800 for 108,000 feet board measure does not allow for any labor putting it in.

Mr. Dillman: That $3800 for 108,000 feet B.M. allows a good deal for labor.

Mr. Hazen: If there is any duplication, we want to find it and remove it.

(It was decided to leave it and look it up, and take the matter up the following day.)

Lippincott

Witness: JOSEPH BARLOW LIPPINCOTT for Plaintiff.

DIRECT EXAMINATION BY MR. GREENE.

I am 51 years of age, and am a graduate of the University of Kansas, I think in the year 1886. I got the degree of B. S. from the University of Kansas in 1886. I was subsequently given the degree of civil engineer. I worked a number of years for the Santa Fe Rail-

5462 road, and Missouri, Kansas & Texas, having been a division engineer on those roads. I was with what has been called the Powell Irrigation Survey, in 1889. That was a federal irrigation survey. I was detailed in a minor capacity to investigations in New Mexico. I worked with the Bear Valley Irrigation Co., as an assistant engineer, at Redlands, from 1892 to 1894, and was engaged in building tunnels and masonry line tunnels. I was hydrographer for the United States Geological Survey from 1894 to 1904, engaged in the study of the available water supply, and reporting on irrigation work in this state. During that period I reported on a number of possible federal propositions, including the building of a dam in Arizona on the Gila River at San Carlos, which would be done in part for the Indian Service. I also made investigations and reports involving the construction of dams on Stony Creek, the Kings River, the Santa Ynez River near Santa Barbara. I was engaged in private practice in Los Angeles between 1894 and 1902, working for the cities of Los Angeles, Pasadena, San Francisco, San Pedro, and for the Seaside Water Co. that supplied water to a number of smaller towns. I was the supervising engineer on the United States Reclamation Service, having jurisdiction over a territory extending from Southern Oregon to Eastern Arizona, and including the Colorado River, between 1902 and 1906. I built a portion of the Klamath Project, and the Yuma Project during that time, and constructed, or had charge of the construction of about 40% of the Laguna

5463 Dam in the Colorado River. I have been in charge of, or as consulting engineer more or less, directing the work of the water department of the City of Santa Barbara for the past 10 years, having had charge of the driving of a tunnel 4 miles in length, and the building of a dam,

which is partially constructed, but not completed. That was to be a masonry dam. That will be a concrete dam 180 feet high ultimately.

I was the assistant chief engineer of the Los Angeles aqueduct from July, 1906, to August, 1913, having to do with the building of 100 miles of concrete covered aqueduct, 4 earthen dams, about 120 tunnels 50 miles in length, and 10 miles of large steel pipe. I had to do with the excavation work, and quite a good deal with the cost keeping. I was employed in the Hawaiian Islands by the Oahu Sugar Co., where I laid out the preliminary engineering work on a large irrigation proposition involving about 5 miles of tunnels, and the irrigation of about 30,000 acres of land; that has now been built. I have particularly reported on an Idaho Dam, near the City of Mackey, for the City of Mackey, and I also have been on the Los Angeles County Flood Control Board, working on the Mojave jointly for the Reclamation Service, and local water users, water supply of San Diego, Imperial Valley Irrigation District, and the Union Oil Co., in building oil reservoirs for storage of oil. At the present time I am the engineer of the San Fernando Valley Irrigation District, in Los Angeles Co., 77,000 acres. I am acting consulting engineer for San Pedro, Long Beach, Denver Riverside, Ferndale Water Co., Little Rock Creek Irrigation District, the City of Santa Monica, Dominguez Estate, Spring Valley Water Co. I have written a number of official publications, and have had to do with the valuation of the following waterworks: Pasadena Water- 5464
works for the City of Pasadena, which was purchased; Los Angeles Waterworks for the City of Los Angeles, which was purchased; Santa Barbara Waterworks, which was purchased by the City of Santa Barbara. I am now making a valuation of the combined waterworks of the City of Santa Barbara. I valued the water rights of the Peoples Water Co., and appraised the San Gabriel Valley water system, which supply a number of small towns in the San Gabriel Valley.

Questioned by Mr. Searls.

There are two systems in Santa Barbara, but I helped to build the municipal system, and then helped to appraise a private system which the city purchased. I acted for the City in both instances. I have appraised the Long Beach Waterworks for the city for rate fixing purposes, and the Redondo Waterworks for the Redondo Water Co., which is a private corporation.

SEVENTY-SIXTH HEARING. DECEMBER 9, 1915.

Witness: J. B. LIPPINCOTT for Plaintiff.

(Certain corrections noted in the record).

5465-5466 DIRECT EXAMINATION BY MR. GREENE.

5466 I am familiar with the property of the Spring Valley Water Co. outside of the City of San Francisco, and am familiar with the tunnels in the city. About three years ago I spent approximately a week
5467 in and around the reservoirs down the Peninsula. I have visited the site of the Crystal Springs Dam, and the rock quarries, and have been over the roads between the dams and San Mateo, and the points on the railroad below. I visited the gravel beds in the Niles Cone, and along the Alameda Creek, and I have been to each one of the tunnels on the system. I had been over the system a good many times before this inspection. I have done work at various times for the Spring Valley, and am more or less familiar with the system. I made a valuation of the Crystal Springs Dam as of December 31, 1913.

I have endeavored to make an estimate of the cost of reproducing new the Crystal Springs Dam as of December, 1913. I assumed that the concrete was what we might possibly call straight concrete; that is, without large stones embedded in it. I also assumed in this computation that while the dam might be built with expansion joints in it, that it was not built in all of the blocks that evidently was prac-
5468 ticed in the case of the original construction. I have assumed that the mixture that went into the construction of the concrete for the dam was approximately composed of one part of cement, three parts of sand, and six parts of broken stone.

My experience with hauling is that hauling with automobile trucks has not proven a success where the roads are poor roads or dirt roads. In case the roads are high-grade concrete roads, or with a fine surface, the hauling might be done to advantage with trucks. The figure that I have used for hauling is a figure that I believe could be accomplished with teams in case the trucks were not used. On page 5 of a table of hauling costs which I have prepared, is given the statement "From San Mateo to the bottom of the Crystal Springs Dam, 4 miles, 25 cents per ton mile; from San Mateo to the top of the Crystal Springs Dam, 4½ miles, 25 cents per ton mile." Those are the hauling rates which I used.

We had a very extended experience in hauling materials of different classes on the aqueduct. We called for bids for hauling on the ordinary desert roads, and our bids ran usually about 25 cents a ton mile on reasonably good desert road. After some experience in call-
5469 ing for hauling bids, we purchased our own mules, charged them against the hauling at a reasonable rate, and did the hauling for sub-

stantially lower figures. For the flat, level roads, we did the hauling perhaps for 15 or 16 cents a ton mile, and where the roads became somewhat hilly, costs were from 25 to 35 cents per ton mile, and where quite hilly, or where there was bad sand, the hauling costs were perhaps 35 or 40 cents a ton mile. By the expression "ton mile" I mean the cost of hauling 1 ton one mile. We have recently been hauling cement and various materials from the Southern Pacific siding at Santa Barbara a distance of about 5 miles to the Santa Barbara Tunnel, a rise in elevation of 1200 feet, using automobile trucks, at a cost by contract of 50 cents per ton mile. The road was rather steep, and in some places crooked, and I believe the figure I have used of 25 cents a ton mile for hauling to the San Mateo Dam, considering the rise in elevation, and the character of the roads, is a reasonable one. Where the haul is back into the hills, and over roads that are quite steep, I used higher rates than 25 cents per ton mile, but that does not relate to the Crystal Springs Dam.

Cement: I am satisfied that there is a very tight combination agreement on the selling cost of cement on this Coast. When we started the construction of the aqueduct, we had obtained a legally low railroad rate; we called for bids for a very large amount of cement. The bidders were requested to quote a price on cement, de- 5470
livered at their mills, f. o. b. cars, and the name of the town of Mojave was not mentioned in the specifications. When we received bids, they all agreed to a cent as to the cost of a barrel of cement, and every bidder named the town of Mojave as the point of delivery. It was for that reason, very largely, that we felt justified in the case of the aqueduct in trying to break that combination price on cement by starting the construction of a cement plant. Within the last year I have participated in the purchase of a considerable quantity of cement for the City of Santa Barbara, and have used every effort to break through that combination price on cement, but have not been able to do so.

Questioned by Mr. Searls.

We did it on the aqueduct after we had built our own mill. I have no question at all but that the cost of manufacture of cement is very much less than the market price at which it is sold; be that as it may, there is a rigid price for cement, as far as my experience goes, on this Coast. Recently the City of Santa Barbara paid $2.12 a barrel for cement net, delivered at Santa Barbara. I believe that Los Angeles is now paying in the neighborhood of $2.10 a barrel net. I 5471
have simply considered in this estimate that I was not justified in assuming that cement could be bought and delivered f. o. b. the cars at San Mateo for less than $2.10 a barrel. The cost of manufacturing cement is a very interesting thing; if the mill can be run to absolutely full capacity all the time, you can get a low unit cost of manufacture, but it was our experience that it cost within a small fraction of as much to run our mill when it was operating at half capacity, as when

we were operating at full capacity. If we would make 30,000 barrels of cement at a cost of $50,000, the capacity of our mill being 1,000 barrels a day, and we reduced our output, say, to 20,000 barrels, the next month our operating cost would be almost as great—perhaps $45,000. In other words, the essence of cheap cost of manufacture is absolutely the full load in the mill. The capacity of the mill has a great deal to do with it. A 5,000 barrel mill can manufacture cement at a lower unit cost than a 1,000 barrel mill. I have looked up, just casually, one month's operating cost of the aqueduct cement mill, and find as follows—this is from a report of the cost-keeping department of the aqueduct, entitled "Resume of aqueduct construction of Sep-
5472 tember, 1911." In this I find the following: 28,849 barrels of clinker burned at .981 per barrel; 39,817 barrels finished grind, .408; 20,589 barrels, sacked and shipped, .086. Operating cost per month, $1.476. That is the total of the cement sacked, and I presume f. o. b. at the mill. I should think that would be a fair figure for the normal cost. We strove to get down to a cost per barrel of about $1.35. That did not include depreciation, overhead, or profit.

Questioned by Mr. Dockweiler.

I would say that the mill was a modern mill. We had high-grade kilns; we had favorable deposits of clay; our limestone deposit was perhaps not as good as some, but the principal handicap we had was the capacity of the mill, which was 1,000 barrels per day. The estimate given us as to the cost of manufacturing cement, by a very experienced cement manufacturer, was $1 a barrel. The aqueduct cement mill was effective in breaking the price of cement.

Questioned by Master.

In considering the price of cement, I have borne in mind that
5473 this is litigation covering a period from 1907 to 1914. For each of the years involved I would make the same valuation.

DIRECT EXAMINATION BY MR. GREENE.

I am familiar with the price of cement in the City of Los Angeles for the last ten years, and I know that the net prices that have been paid there during the last five or six years were in the neighborhood of $2.10 a barrel net. I have been paying those prices at Santa Barbara and other places. I do not believe it is costing manufacturers $2.10 a barrel to make that cement. I also feel that the price that Mr. Dockweiler mentioned of 68 cents quite possibly does not include depreciation of the mill. I may be mistaken, but I would
5474 be very much surprised if it did. I took $2.10 a barrel f. o. b. San Mateo for cement, because that is practically what I have been paying in private contract for cement. I have been a Park Commissioner in the City of Los Angeles, and for the last six years we have been buying cement off and on under the regular city purchasing contractors, and that is about what we paid for it.

Sand: The Crystal Springs Reservoir site is situate in a region where the rocks are sedimentary rocks, and usually the softer rocks, when they decompose, do not furnish sand. I did not find any large quantities of sand in that neighborhood; neither did I find sandstone, nor quartz rocks that were suitable for the purpose of rolling sand and pressing it as was done at the Roosevelt Dam. I have assumed that the sand will be obtained from the Niles Cone, and those sands are of good quality. There are plants over there that are equipped 5475
to handle them. I have assumed that these sands have been put on the train and hauled over to San Mateo by rail, and then hauled by wagon from San Mateo to the dam. The figure that I have as the initial cost of sand delivered to San Mateo is based on a letter written on May 14, 1914, by C. B. Head, purchasing agent of the Spring Valley Water Co., to Mr. Sharon, in which are quoted the prices of sand delivered to various points, among others being San Mateo at 85 cents per ton.

"J. J. Sharon, Esq., "May 14, 1914. 5476
"Building.

"Dear Sir: In answer to your inquiry of May 12, 1914, I beg to "advise you of the following current prices:

"Sand (to ¼ inch) in pits, at Niles, 55 cents per ton.
"f. o. b. Pleasanton .....75 cents.
"f. o. b. Sunol .....75 cents.
"f. o. b. Belmont .....85 cents.
"f. o. b. San Mateo .....85 cents.
"f. o. b. Millbrae .....85 cents.
"f. o. b. South San Francisco .....85 cents.
"f. o. b. Ocean View .....85 cents.
"f. o. b. San Francisco .....80 cents."

This sand I understand to weigh 2700 pounds to the cubic yard; a cubic yard of sand contains 1.35 tons. I have weighed a great deal of sand, and have found that it weighs as a rule from 2700 to about 3,000 pounds per cubic yard. That is just as it comes from the pits. As a rough check to the figures of Mr. Head, I made an approximate estimate on the cost of the delivery of that sand, as follows: The cost of the sand itself, in the pit 12½ cents a cubic yard: 5477

Loading in pit	10 cents.
Stripping the surface soil off the sand, about	5 cents.
Tram to the screen	8 cents.
Screening	10 cents.
Loading into railroad cars	5 cents.
Adding for general overhead charges, 40%	20 cents.
Railway freight to San Mateo, 25 cents per ton	35 cents.
Total	$1.05 a yard.

The figure that I used was 85 cents a ton f. o. b. San Mateo.

Rock: The quarry that was used, and which could be used still, for the making of this concrete, is about ¾ of a mile from the dam by wagon road. The stone consists of what might be called a trap rock; a metamorphosed sandstone that is very hard, and which would break readily. I have developed the cost of this broken stone, assuming that it came from this quarry, and that is shown on page 7 of the memorandum. I have assumed that the cost of quarrying and crushing the rock is 90 cents per cubic yard, and a haul on a tram of one mile, at 10 cents a ton mile, and that the rock weighed 1.4 tons to the cubic yard. This gives 14 cents per cubic yard. The washing of the rock is 10 cents. Total cost $1.14 per cubic yard of crushed stone delivered to the dam. The prices of lumber I have taken both from the
5478 quotations of the purchasing agent, and from my personal knowledge of the prices at which lumber has been sold along this Coast during the last five to ten years. I have assumed that rough Oregon pine can be purchased at San Francisco for $15 a thousand; that the railway haul to San Mateo would be $1 a thousand; unloading from the cars 25 cents, and the wagon haul at 25 cents a ton mile to the dam, $1.86. The rate on the lumber from San Francisco to San Mateo was 60 cents a ton, and that reduced, to $1 a thousand. The framing charge for the lumber that is going into the tunnels I have put down at $15 a thousand, making a total direct charge of $34.11. The lumber that was used in connection with the building of this dam is not a large item in the construction of the dam.

These unit prices that I am now quoting and giving are the unit prices for the going work. That is, the actual working prices, such as you might find from staying on the work a day, and noting the
5479 amount of work done, and the number of men engaged on the work, and the resulting unit price. The total unit cost for anyone of these classes of work I consider as quite a different figure, and one which should be made to cover all the incidents due to what I have called indirect, or auxiliary expenses such as might be occasioned by delays, floods, fires, and so on. These unit prices for mixing and placing I obtained from the following authorities: On a large Government dam with which I was acquainted, the direct mixing and placing cost was $1.21 a cubic yard. On another large dam with which I was acquainted in California the mixing cost was 95 cents per cubic yard.

5481 The memorandum from which the witness obtained these authorities was offered in evidence and marked "Plaintiff's Exhibit 112".

At Santa Barbara, at a dam called the Gibralter Dam, the direct cost for mixing and placing concrete in the base of the dam was 89 cents per cubic yard. From these three figures, $1.21, and 95 cents, and 89 cents, I accepted a figure of $1 a cubic yard for the direct cost of mixing and placing in the Crystal Springs Dam. I have had to do with the mixing and placing of a great deal of concrete, and I should

regard that otherwise as a reasonable figure to use. I have forms down in the Government dam, in the power dam, and the forms were included at the Santa Barbara Dam. I would like to strike out the statement "Excluding forms" in the statement at the bottom of page 6, of Exhibit 112, reading "Accept $1 a cubic yard for mixing and "placing, excluding forms." I have a substantial percentage for overhead that I would expect to cover a multitude of items of that kind. 5482

Questioned by Master.

In this mixing and placing, I assume the most modern methods developed to date. There really is only one method I am familiar with in placing concrete effectually, and that is the method of placing concrete in tunnels by compressed air. The idea I had about mixing concrete and placing it in this dam is somewhat as follows, and is controlled very largely by the fact that the dam is an arch dam. I have thought that in building this dam, a number of towers such as are used in the city, with elevators, might be placed along the upper side 5483 of the dam where the slope is almost vertical, and the concrete raised through those towers and discharged on to the dam through the spouts. It would be mixed on the upper side of the dam and hoisted, and then discharged through the spouts. Where dams are straight dams, the most effective way is to handle the concrete by means of cableways and skips. On the large Government dam that I spoke of they handled their materials in that way. Where the dam is curved, it introduces a problem of having your cables on a straight line, and your dam on a curve, and it is rather awkward delivering materials. On these large Government dams they had 2 or 3 cableways over the dam, and the concrete was hoisted, put on these cableways, and run out, and then dumped into spouts and conveyed to the exact point in the dam desired. That was my conception of how that might be done in this place.

Page 7: Estimate of the cost of 1 cubic yard of concrete, starting with the cement at San Mateo at $2.10 a barrel, and arriving at a direct cost by the process I outlined of $5.97 per cubic yard. I have added 40% to that $5.97, or $2.39, making a total cost per cubic yard of masonry of $8.36.

Stripping of the foundations: The Gibralter Dam shows a direct 5484 cost for stripping of $1.66 per cubic yard. That is wet sand and gravel. The stream had to be handled, and extensive pumping done. The indirect cost amounted to $1.48; that made a total of $3.14 a yard. The estimate on the cost of that work was $2, which I joined in making. In the large Government dam the final cost was $1.50. I have here tabulations of bids for that class of work at the Roosevelt Dam, and the price for which that contract was laid was $1.75. I used at Crystal Springs Dam $1.50.

Stripping foundations of rock—page 8—is difficult to estimate on. It consists largely of detaching loose pieces of rock, and getting

a bed-rock that is solid and free from fragments of rock, and also the excavation of a footing trench, or key trench, for the purpose of anchoring the dam so as to prevent seepage underneath the structure. Those costs are apt to be irregular, and I have simply done the best I could in giving information of that kind.

At the Gibralter Dam it consisted very largely of cutting small trenches into bed-rock. At the large Government dam it was $2.31. In the estimate we prepared of the Gibralter Dam we used 50 cents, which was entirely out of harmony with what the price ultimately was, because of the character of the excavation of these trenches. I used for Crystal Springs Dam $2.

5485 The cost of the tunnel; is indicated on page 16 of this memoranda. It is a short tunnel, and it has been my experience that where a job is a short, or detached job, you have to bring your organization on to it and have them work relatively a short time and then break them up, and the unit costs are greater in work of that kind than where there is a large piece of going work to be carried through a long period of time. This tunnel estimate is high for that reason, and for the further reason that the tunnel would have to be excavated very carefully, and heavy shooting avoided.

There is very little brick work in connection with the building of this dam—the laying of the brick around the pipe and in the tunnel. In the other tunnels I have estimated on, I have not figured on brick at all, because it seemed to me that it never would be built that way nowadays, and brick is more expensive and more cumbersome to work. In the case of the Crystal Springs Dam I figured on brick lining 207 M. at $50. I figured on brick in this case, but not in the other cases.

5486 The puddle work I have estimated at $1 a yard. That is in the Howard Cut. I am not familiar with the method of placing a puddle as was used in the building of these dams. The earthen dams that I have had to do with have been placed by other methods, and I do not know that my judgment on that is the very best. I have made a memorandum as follows for the puddle estimate:

Stripping, per cubic yard	10 cents.
Loading on to wagons	30 cents.
Hauling, 2000 ft., at 1 cent per yd. per 100 ft.	20 cents.
Spreading	5 cents.
Sprinkling and rolling	20 cents.
Overhead, 40%	34 cents.
Total	$1.19

I rounded that out to $1.20.

Auxiliary and indirect expenses: You may make an estimate of unit cost of doing a piece of work with care, like the estimate of mix-

ing and placing a yard of concrete, but there are a great many incidents that go into the cost of a finished structure that are impossible to foresee. At Santa Barbara years ago I made an estimate of the cost of excavating the Santa Barbara Tunnel, which is about 7 feet high and 6 feet wide, and my estimate was about $12.50 a foot. We advertised for bids, and let the contract on each end of that tunnel to contractors who were secured by adequate bonds from bonding companies. Before we got through with the work the tunnel had cost considerably over double my estimate; both the contractors had disappeared from the work, and we had to take over their inadequate equipment and finish it. The reason for that was because of the numerous things that came into the construction that we were unable to foresee. I think that if there is one distinctive feature on the construction of the Los Angeles Aqueduct that pre-eminately stands out is that fact that there was very little in the way of overhead expenses, and still these indirect or auxiliary expenses, together with the overhead on that job, amounted to 33% of the cost of the finished structure. That percentage is the lowest percentage of any large piece of work with which I am familiar, and of which I have reliable information. 5487 5488

I have here a paper entitled "Los Angeles Aqueduct, general exhibit and recapitulation of reconstruction costs"——

Questioned by Mr. Searls.

That was prepared by Mr. Clemens. I was through several years of construction work on the United States Reclamation Service, in which we had struggled to get unit costs promptly and accurately, and in which we had not been quite successful. When this aqueduct work started, I made it my particular business to see to it that we did get accurate unit costs for the construction of that enterprise. We obtained a construction auditor, familiar with these cost-keeping methods, from the Harriman Railroad System. We issued what we call a work order for each particular piece of work, carrying with it an estimate. These work orders were the basis of the authority for doing the work. Each month we issued a bulletin giving the unit cost for that current month on that particular piece of work. The average unit cost on that piece of work compared with the estimate unit cost. It was my portion of the work, very largely, to follow through those unit costs, and see as to the reasonableness of the cost of the work. These auxiliary expenses here are made up as follows:

Service and general engineering; that was preliminary surveying.

Pipe lines. By that is meant pipe lines supplying domestic water for the camps, and construction water; maintenance and operation of those pipe lines.

The building of telephone lines; telephone lines very largely for purposes of construction; the maintenance of telephone lines. 5489

Roads and trails; the maintenance of roads and trails. We spent on roads and trails $274,000.

Questioned by Mr. Searls.

That included all the roads that were built in connection with the construction of our aqueduct. We built a road practically to the portal of every tunnel. Those roads were built for the purpose of construction. The building of the road in the flat desert was not a large item, but in the hills and mountains it was quite a large item. There were several hundred miles of roads and trails. In Owens Val-
5490 ley, where the country was flat, we spent $10,000 for roads of about 41.6 miles. That was just clearing out sagebrush and so on. On the Jaw-bone Division we built 159 miles of roads and trails, costing $88,857. This particular summary includes all the roads and trails.

DIRECT EXAMINATION BY MR. GREENE.

Building expenses, net; we spent $336,000 for that.

Low tension power lines, $59,000.

Division administration, $775,000.

Miscellaneous tests. Expended cement sacks—the loss of cement sacks, $49,553. Patrolling the aqueduct. Miscellaneous losses—due to fire, and due to live stock dying and being stolen, and things of that sort.

Reorganization expense—that is where we ran out of funds, and had to store our camp outfits, and then get them out again; that cost
5491 us $28,000.

Concrete replacement; where the concrete was not satisfactory, and was torn out and replaced, $72,000.

Equipment expenses; net cost of equipment after we got through the job, and had sold our equipment, and credited the equipment account with what we got, and what we estimated on hand was worth; that amounted to $1,548,721.

Those construction auxiliary expenses that we could not directly distribute to our unit costs amounted to $4,271,500. In addition there were general miscellaenous expenses and operations, such as the passenger transportation of labor, investigation of water, sundry adjustments—very largely freight adjustments; subsistence losses—that is where men came out to go to work, but did not go to work, and there were meals to be paid for; unadjusted freight; stock service; miscellaneous adjustments, and so on. This account is credited by discount on bills, hay sold, equipment rental, hospital rental, rentals, equipment service, Owens Light & Power Co., light generated, and so forth; the net debits for these items amount to about $277,000. What I am trying to impress is the fact that after you make your unit cost estimates as reasonable as you can, there still remains a large amount of expense due to all these things, and that is a very material element. In

my judgment it is that feature more than any other one thing that makes for the expression, which is more or less common, that the estimates of engineers and architects are too low. It is because of the difficulty of foreseeing expenses of this character.

5492 In the case of this large Government dam, they have, by their method of accounting, a series of entries that they call inactive accounts not distributed on the unit costs. These are described as follows—page 20: General expense; testing dam site; right of way for reservoir; clearing the reservoir site; telephone system; wagon road construction; railway construction; repairs and betterments; camp construction; diversion work; sand and gravel stored for concrete; pumping, backfilling and puddling; laboratory; camp maintenance and heating. I have arbitrarily, myself, by making this classification, reached a figure of $1,216,148 for indirect costs. The total cost of that work to May 1, 1914, was $3,336,098, leaving by deduction a direct cost of $2,120,950, or a ratio of indirect to direct of 57.4%. The defect is that we have distributed these indirect costs on an uncompleted structure; however, they are distributed over the funds and spillway Foundation and on 256,000 cubic yards of concrete. The overhead expense amounted to $278,487. The ratio of this to the direct is 13.1%. We

5493 get as a conclusion that which I call the auxiliary, or inactive expense, in the case of this dam, amounting to 44.3% in addition to the 13.1% for overhead or general expense.

In the same way—page 23—I arrived at the indirect expense on a large power dam in California of 40%, and an executive or overhead expense of 13%. I have found that in this power dam the indirect is 40%; in the Government dam it is 44%; at Santa Barbara it was 67%; on the Los Angeles Aqueduct for indirect it was 28½%. The 67% at Santa Barbara is excessive, because that was work on foundations very largely. The result I considered justified a charge of 40% for indirect expenses, which I have added to the unit cost which I have developed in this estimate.

I did not see Mr. Hazen's figures, or any other figures on the cost of this dam until my figures were completed.

5494 I made a very extended estimate for the City of Denver last summer for the new water supply, in which I added 35% for indirect expenses. I have just completed a large estimate for a storm water sewer system for Santa Monica, in which I have added 40% for indirect expenses. That is my practice.

5495 The 40% would cover all of the charges that could not be made directly to the unit construction cost of the finished structure, exclusive of what they might possibly call the general executive expenses. That would include roads, low tension power lines, and telephone lines. My estimate is made on the basis of the day labor costs, in which instance all these auxiliary expenses would have to be paid by the owner of the property, but if that work was let by contract,

the contractors would have to look out for a great many of those ex-
5496 penses himself. The figure that I have given, with the 40% added, is hardly the figure that I would expect a contractor to bid on the work for, as it does not include profit. If I were the engineer of the Spring Valley Water Co., and they were undertaking to reproduce this dam, I would recommend that the work be done by the company by day labor, and this would be my estimate to the company of its cost.

Questioned by Master.

There are two periods of grief in the construction of a job; one is the period during which you are organizing, and during which things are going wrong generally, and you are trying out men in order to reach an organization which is an efficient machine; the other period is when you are nearing the end of the work, and everybody realizes that the end is approaching, and the time for them to go down the road has about been reached, and they slow down, and lose their ambition to make a record in prices and quantities of work. These
5497 figures that I have, I think, take care of both ends of that.

If the Spring Valley Water Co. consisted only of these elements which I have put my figures on, these would be the figures I would use, but I have not included the general executive expenses, which will include the expense of the Sutter Street office in this case, and the expenses of the general executive supervision of the work, the auditing of accounts, the legal expenses, and so on. You would have another overhead addition, in addition to the 40%. Interest during construction is not taken care of in my 40%. I would have in mind as an overhead, the general engineering, and legal and administration
5498 expense, and it would not be included in the 40%. The incidentals, contingencies, and omissions, I would say, would be. The addition which I should think would be a reasonable thing to make in the form of organization that I have in mind to cover all these general administration costs would be about 10%. If that work were done by contract, and you had to extend your general executive supervision over the work in a more elaborate way, I think it might be over 10%.

Questioned by Mr. Searls.

If all the roads leading to this dam were constructed and taken care of already, that would affect my 40% somewhat, but I think that is not quite all of it. If you were going to haul 160,000 barrels of cement, together with other general supplies, over that road from San Mateo to the dam, you would have to be working on your roads constantly; in addition you would find there were other roads to be built. I consider a tram road a mile in length from this quarry to the dam, on which the rock can be brought for 10 cents a yard on cars instead of on wagons. That tram, and the grading for it, would be taken care of in my 40%. There would also be taken care of in the 40% the construction of the wagon roads to the dam. The
5499 low tension power line would be included. In our work that we did

on the aqueduct we built three hydro-electric power plants, and a main transmission line. Then, practically, the electric department sold power to each one of the divisions at a reasonable rate; this power bill went right into the unit costs, and when we got all through, we were about $70,000 ahead in our bookkeeping on our power plant.

On the Los Angeles aqueduct we were building a structure on which our quantities are matters of estimate. These unit costs are 5500
the actual costs of the finished construction work; for instance, we build a tunnel over the hill, which by our survey might have called for 2,000 feet, and when we come to finally measure the tunnel up through the complete structure, we find it is 2,005 feet; the unit cost might be out to that extent, or you might lose some cement in transit that you would have to pay for. I think the figures we used in here were the figures for finished structures in these unit costs.

Mr. Metcalf: I think the figures totaled here of $1,746,000 are 5501
substantially comparable with the figures of $1,648,000. I understand that Mr. Lippincott's 40% allowance does include about 1½% for preliminary engineering, and an allowance for their division engineers of something less than 5%. The division engineers correspond to men whom the contractor would have to employ; in other words, they fill a dual position; they act both as inspectors, and as contractor's foremen, so that if the work were done by contract, they would have been required, and in addition to them, there would have been required engineers to supervise their work, so that there is not a duplication in adding to Mr. Hazen's figures an overhead cost which would cover the engineering, and adding to Mr. Lippincott's figures 10% or more as overhead, on that basis of doing the work. There is that allowance of something like 1½% of preliminary engineering which would go into the overhead costs as defined by Mr. Hazen. They are not exactly comparable to that extent. To make Mr. Lippincott's figures directly comparable, we should deduct 5502
1½%.

Questioned by Master.

Mr. Lippincott: That $1,648,000 is the cost which I understand would cover the construction cost, and the indirect costs, without anything for overhead. In the statement I made this morning concerning overhead, I had in mind more in the nature of general executive expense, such as the directors of the company, the legal department, the purchasing department, the accounting department, and things of that sort. If, instead of considering the preliminary surveys, and division administration as auxiliary expenses, you would 5503
consider them overhead expenses, that would modify my statement about 10%, and making that adjustment so as to get that basis of comparison, in using the classifications of accounts that others have often used, you might get an overhead expense from the aqueduct

of about 13½%. I have made a study of what the overhead expenses are when they are considered to include administration, engineering and supervision, and casualty insurance, and the conclusion that I arrived at was about 13.67% for overhead expense when the overhead expense is supposed to include surveying and division administration.

Mr. Metcalf: When I discussed the thing some days ago with Mr. Lippincott, trying to get to the same basis for the two engineers, the same assumption as to what constituted overhead, he suggested that the contractor, if the work were done by contract, might have a certain amount of engineering work to be done which would absorb the 1½% allowance, or a similar allowance such as they have had at the Los Angeles aqueduct in his own experience, and under that
5504 assumption would be brought in to the basis costs corresponding to Mr. Hazen's.

Mr. Lippincott: I have not made any segregation of the 40%, except in the manner indicated in individual instances. Referring to page 7, I show under indirect cost, a statement of what these indirect costs were in the case of the Gibraltar Dam for the City of Santa Barbara. I have shown on the following page what the direct costs were, and have also done that in the case of the Los Angeles aqueduct by reading what the details of the indirect costs were. On page 20 I have given a list of indirect costs on the large government dam. If this work should be done by contract, it is my idea that you would have to have an engineering organization on the different divisions directly representing the company, or the owner of the property, the purpose of which would be to inspect the work, and to measure up the number of units of work that the contractor has performed; that there would be a larger organization than that, we have classified as engineering in the aqueduct organization. We would have a division with a tunnel superintendent or foreman, and his salary would usually be charged directly against the cost of the work, and would be included in the unit cost. If the contractor
5505 had that tunnel, he would have to have a man of that kind.

In one instance we contracted a division of work on the aqueduct, and when the contractor came to take charge of the work, he asked us about a superintendent to take charge of his work. We offered him our division engineer, and he accepted that division engineer, and employed him, and kept him on the work until it was finished, and as soon as that contractor took that man as superintendent, we selected another division engineer and put him on the work. I have not changed my mind, but it is simply a question of explaining it. Now, if you would add what we call division engineering, and preliminary surveys, to the general executive, you would
5506 get about 13½% for what might be called an overhead on the aqueduct.

Questioned by Mr. Searls.

I have included in my auxiliary costs an item for preliminary engineering; irrespective of whether the work was done by contract, or was done by day labor, if I accepted Mr. Hazen's basis for overhead, I must include that preliminary engineering in my regular overhead basis, and the contractor would not have an engineer to do the preliminary.

Questioned by Mr. Greene.

The general administrative expenses of the city were not charged against the aqueduct. That included the expenses of the City Attorney's office, the City Auditor's office, and the City Treasurer's office. The regular special attorneys' expenses were charged against the aqueduct.

Questioned by Master. 5507

The assistance that was given by the City Officers, otherwise paid, saved expense to some extent on the aqueduct. It is my impression that Mr. Mulholland, as the chief engineer of the Water Department, did not receive any compensation from the sale of aqueduct bonds. I think that is true of the Board of Public Works also. They were not included in that 13.7%, and as I said, I think the one distinct feature about the aqueduct organization was its lack of over- 5508
head development, and the expenses that go with things of that kind.

Mr. Hazen: I think this illustrates the difficulty that I spoke of when I was speaking of the Los Angeles data some time ago. It is very difficult to compare statistics from different work, unless one thoroughly understands all the facts and goes into them adequately. When I meet Mr. Lippincott, and we talk of concrete, he tells me that he puts it in for $5 a yard, we will say, not attaching any significance to the figure, and I tell him $7, and he thinks I am a very expensive man, and I do not see how he does it, but when we get together, and thresh it all out, we are not talking about the same thing. I include in my figure the whole cost of doing the work, right up to the supervision, and he includes only direct cost, and he has his indirect costs which he is carrying in another column, and which really make up the difference. When we get together and thresh out the problem to the end, we find we are not so far apart. That is characteristic of cost data all over the country. Different 5509
organizations keep their records in different ways, and in my experience it does not do to take it too seriously, unless one really knows just how it is done.

I have included contractor's profit in my figure. I assume a moderate, normal contractor's profit all the way through, but with the idea that any parts of the work that can be advantageously constructed in another way, and ordinarily are so constructed, will be so constructed. In the pipe laying in city streets it is the exception

to contract that, and I have not figured any contractor's profit in my estimate for that, but on dam construction and tunnel construction, and the large pipes, it is customary to do that work by contract. I suppose among American cities there is not one city in ten that could afford to do the work of the kind represented by the Los Angeles aqueduct by day labor; the other nine-tenths of the cities will spend a great deal more by doing it by day labor than the work
5510 can be contracted for. Nothing that I have in that 50% allowance is in Mr. Lippincott's indirect cost allowed for at 40%. I should say this allowance for preliminary engineering was in the 15%. I tried to get my omissions into my unit prices, and I assume that the contractor allows for them. The extras are in my unit cost too, except where occasionally, if there is an item for them, of course it is noted.

5511 Mr. Metcalf: What we have aimed to give was a strict parallel in the estimate of Mr. Lippincott on his basis of doing the work, of having the company or the municipality do the work itself, and of applying to that the overhead which he thinks would result; on Mr. Hazen's basis, the doing of the work by contract to such extent as might be advantageous, and which would involve, in his judgment, an additional allowance of 15% for overhead. Of course the interest during construction being added in each case to the resulting figures; it being assumed by him that if the work could be done more cheaply than indicated by those figures, by contract, that it would be done by contract, but it being his belief that the final cost of the work under these prices would be the figure at which he arrives by that method of computation. In other words, the two methods of computation grow out of general differences in practice in this part of the country and the East.

Questioned by Master.

Mr. Lippincott: If I should continue my valuation beyond the limits to which I have gone, I would make certain further overhead additions of possibly 13%, and then an addition for interest during construction.

Mr. Hazen: The work contingencies are correct in my 15%. There are always some expenses that cannot be classified. On the Little River work at Springfield, there was a great deal of expense for taking state officers, county officers, and town officers over the work,
5512 and in taking the members of the various city committees. Everybody had to go in an automobile, and be provided with a good lunch, and in the course of several years it ran to quite a large figure. As to whether the washing out of the dam by flood would be included would depend upon how the contract was drawn up.

Mr. Lippincott: With the Santa Barbara work I think we had a charge of about $4,000 for extras. In the case of the Roosevelt the contractor's foundations were washed out twice, and I think he had to stand for it in that case.

Mr. Hazen: There was a dam that washed out at Denver when it was partly built that cost the company $150,000, and the company stood that. I did not put anything in my unit costs for costs of that kind. The 15% that I use would not stand a very large loading of that kind.

Mr. Metcalf: The difference between Mr. Lippincott and Mr. 5513
Hazen of $100,000 is in the unit costs of the concrete, primarily.

Mr. Hazen: I should say that the difference was that I have assumed good, average management, and a fair profit to the contractor, and Mr. Lippincott has assumed that a man as skillful as he is himself will complete the work for the principal without profit.

5514

Questioned by Mr. Metcalf:

Referring to page 20; I should think particularly the laboratory charge of $10,761 might appear as an overhead charge under Mr. Hazen's method, and also it is my understanding that there is no charge made in that list shown on page 20 for the general executive expense of the Washington office.

Referring to page 24 of exhibit 112; the first column shows the name of the dam, the second the class of the work, the third shows 5515
whether the various costs are actual construction figures or estimated figures, the next column shows the number of cubic yards actually going into the structures, or estimated going into them, the next column shows the total cost of the dam, exclusive of real estate, as nearly as I could make it. It includes everything, foundations, gates, towers, concrete, everything of that sort. The column headed "Direct" is the figure that has been used either in the estimate, or in the classification as relating directly to the cost of the concrete alone, without any indirect or overhead charges. The column marked "Total" is simply the total cost of the dam, exclusive of real estate, divided by the number of cubic yards in the structure, giving a gross figure, which is rather an index figure than typical of the cost of cubic yard of concrete. The abbreviation "cl. concrete" means cyclopean concrete. 5516

Yesterday Mr. Hazen referred to an audit of the cost of the Crystal Springs Dam by Mr. Wenzelburger, from which he made certain deductions for real estate, and perhaps for the Upper Crystal Springs Dam, arriving at a cost for the Crystal Springs Dam proper, complete, of $1,945.00. I consider that as an actual construction cost. The last line of the table shows my estimate without overhead of $1,648,000 divided by the yardage, giving $10.49 as an index figure to my estimate. I did not, on my Crystal Springs cost, understand that Mr. Hazen had excluded the cost of the auxiliary structures of Crystal Springs Dam from his computation. This item of $12.35 includes all the tunnels and gates and auxiliary structures, and also a greater part of the overhead.

CROSS EXAMINATION BY MR. SEARLS.

My first experience with concrete dams was probably on the Bear Valley work, where we put in the foundation of a concrete dam
5517 about 1892 or 1893. I was on that job as a minor employee. The next one was the construction of the Laguna Dam, of which I was supervising engineer. I was with the construction of that work until it was about 40% completed, and then I left the Reclamation Service and went to work for the City of Los Angeles. That dam was an unfortunate venture for the contractor. I think he did not handle the work as well as he might. It was a mile long, and about 20 feet high at the river, and runs from that to perhaps 10 feet high. It is what might be termed as a weir. That was the only dam that I had direct connection with in the Reclamation Service, although I was associated in a general way with the other engineers, and had the benefit of their experience with other dams, and I visited the other dams. I did not build any concrete dams on the aqueduct. I built a dam for the City of Santa Barbara which was of sand and gravel, into which we placed boulders by hand. You could hardly
5517A call it a cyclopean masonry structure. The method of construction on the Gilbralter Dam consisted in hauling cement from the railroad by automobile trucks through a long tunnel at an elevation of 1200 feet. We then hauled the cement through this tunnel with electric trams, and took sand and gravel from the stream bed, and mixed it with the sand, hoisted the aggregate in a tower, and ran it through spouts to the dam. The foundation was, I think, 5,000 or 6,000 yards. There were 5,160 cubic yards of concrete, and there was used approximately a barrel to the yard. I think the City paid $2.12 a barrel for the cement f.o.b. at Santa Barbara.

It is pretty hard to say what our Tufa cement cost on the aqueduct. We took the Tufa cement, and a barrel of what we might call straight cement, and blended it by grinding, and the cost of that I do not remember exactly, but it was somewhere in the neigh-
5517B borhood of 40 cents for each barrel of blended product. That is 2 barrels of our product would cost the price of 1 barrel of cement, plus 80 cents. We bought a great deal of cement f.o.b. Colton for $1.05. We bought other cement delivered f.o.b. Mojave for about $1.40 or $1.45, but those prices, and particularly the $1.05 were effected by the building of our cement mill. The $1.05 cement was bought at the Riverside Mill, and was the first order for cement that they ever placed, and they gave us to understand that if we could place that order with them before a certain date, that they would give us a very different price than they would be able to give us subsequent to that date. My understanding of it was that they joined this combination on the date in question. That was purchased from the Riverside Portland Cement Co. The first bid with them was

for 100,000 barrels, with an option on an additional 100,000 barrels. We distributed a great deal of our cement from Mojave. 5518

Questioned by Mr. Greene.

The City of Los Angeles has been buying cement for about $2.10 to $2.15 a barrel net in Los Angeles for the last 3 or 4 years.

CROSS EXAMINATION BY MR. SEARLS.

I do not know what quantity of cement the City of Los Angeles bought in 1914. From 1907 to 1910, as far as the aqueduct construction is concerned, I think it would be correct to say that we paid a price which at Mojave did not exceed on the average about $1.50. 5519 I think the price of $2.10 Los Angeles which the City Water Department paid the aqueduct for small quantities of cement was in the neighborhood of what was paid around Los Angeles.

I do not know what the Southern Pacific Co. has paid for cement during the years involved in this litigation. I do not know what the State Harbor Commissioners paid for cement during these years, purchasing it in large quantities. I do not know what the State Highway Commission has paid for cement during the year 1913. I did not use their figure in figuring what the cost of cement would probably be. I do not think that a company purchasing 200,000 barrels of cement woud pay the same price for it that a city or company buying 50 or 500 barrels would pay, but it would simply be a question of the attitude of the cement companies as to what they were willing to do for you.

Mr. Hazen: Referring to the purchase of 22,000 barrels in October, 1913, to November, 1914, by the Spring Valley Water Co., for use at Calaveras, at an average net price of $2.13 a barrel, delivered at Milpitas, I think the company contracted for all of that at once, but I am not sure of that. 5520

Mr. Lippincott: Referring to the Spalding Dam; I think that Smart is a station on the Southern Pacific just east of Emigrant Gap, and my memorandum shows 163,166 barrels of cement, $2.19 per barrel at Smart. The difference between $2.19 a barrel at Smart, and $1.80 at the mill does not seem unreasonable to me, but whether it 5521 is a reasonable difference or not, I am not prepared to say. The question of freight rates is about as mysterious a thing as the price of cement. I know that a road contractor on the State Highway was very much distressed from the fact that he had to pay more for cement in Riverside than he would in Los Angeles, and it made quite a difference in his estimate. 5522

I do not know whether there was any rebate in this Spaulding cement contract. I asked the engineer in charge of the work on the Twin Peaks Tunnel, in the City of San Francisco, the cost of cement to the contractor, and it is my recollection that the price was somewhere about $2.

Mr. Ellis: I understood the price was $1.90 for the Stockton Tunnel.

5523 Mr. Hazen: The San Francisco price would be a little less than the San Mateo price. As I remember the quotations I got of last year, the $2.10 and $2.12 at San Mateo correspond with the $2 rate in San Francisco. I am referring to what the Spring Valley paid. I think the rate for delivery at San Mateo is the same as the rate for delivery at Milpitas, and the price would be the same. It is the same thing that we have around New York; cement delivered at New York is delivered at a lower price than it would be delivered
5524 20 miles out.

Mr. Lippincott: My idea about the prices of cement is one that has been in the process of formation through a period of years, and irrespective of this table which I have here, I have a judgment as to what the price of cement would be. The mix that was actually used at the dam there, I am told, was a barrel of cement, 2 barrels
5525 of sand, and 22 cubic feet of stone. I used in my assumption 1 barrel of cement, 2 barrels of sand, and 22 cubic feet of broken stone. On page 4 my requirements for one cubic yard of concrete starts off with a cubic yard of stone, and is based on these figures above. A cubic yard of stone referred to the cubic yard of sand, and 1.18 of a barrel, or say, 1.2 barrels of cement. I do not think that that would make more than a cubic yard of concrete. The way I figured it was that the sand would practically go into all the voids of the stone, and there would be some surplus of cement, amounting to about .24 of a cubic foot that would be diffused through the mass. On my sand I figured 85 cents a ton f.o.b. San Mateo, and that we would get it
5526 from Niles. I accepted the quotation of the purchasing agent at 85 cents per ton f.o.b. cars San Mateo, and I do not go into a computation for a price at Niles, but I think quite likely that sand might be sold at Niles in the pits there at 15 cents a yard.

I do not know what the Southern Pacific Co. paid for sand f.o.b. Inglewood during the years 1913 and 1914, but this sand that I am figuring on is practically a selected sand, and not supposed to contain gravel, because we could get the stone cheaper at the quarry than we could afford to pay for the loading of it at Niles, and transporting to the dam. I do not know what the Harbor Commissioners paid for sand for use in concrete during those years. I assume that the
5527 rock would be taken from the pit, and the only cost would be the quarrying, crushing, washing, and conveying.

Questioned by Mr. McCutchen.

That material would be run through the crusher, and there is a good deal of soft stone, and some clay, and for that reason I thought the stone ought to be washed. We got quotations in connection with figuring on the Sunol tunnels from that Niles country, and I think they were about the same as these.

Questioned by Mr. Searls.

I think I figured that the rock cost $1.14 per cubic yard; 90 cents for quarrying and crushing, and 10 cents for transporting, and then another figure. The average cost of perhaps a dozen quarries that I have a record of here was 86 cents for quarrying and crushing a yard. When I was at the Spaulding Dam they were putting in about 18 or 20 percent of plums. You can get a great deal more than that 5528
of the large stones in dams in that way, but you reach a point where the delay caused by the spreading of these large stones in the dam is more costly than the saving you would accomplish in the concrete. It also depends very largely on the character of the stone used. If you have a stone that breaks in reasonably flat blocks, you can put a higher percentage in than you can of irregular stone. On the large government dam, they started with a very low price on cement, something like $1 a barrel. In addition to that, they ground or pulverized the granite rock and blended it with the cement, so that their cement was a blended cement to the extent of a certain percentage, and in addition to that, after having added the sand and broken stone, they had another large bin of 4 to 6 inch cobbles, and they carried the proportion of the concrete one step further than usual, and put in another batch of cobbles, so that their mix instead of being 1, 3, 6, was 1, 3, 6, 4, and those cobbles were run through the mechanism and out into the hopper, and into the dam in that way. 5529
That is what is meant by the term sand cement in that item. That made the cheapest concrete that I have ever known of, and the cost of making the blend to each barrel of blend product figured about 68 cents per barrel. The Government paid $1.56 per barrel for the cement f.o.b. dam site. The cost of the plum rock was comparatively a small item. There is plum rock here which was apparently put down at a cost of 7 cents a yard. The total on this memorandum that I have here apparently is about $10,000, but that may not have been during the entire construction of the dam. The elements there naturally reduced the cost of the concrete. The cost of putting the 5530
plums in was not great, but it saved on the concrete.

My recollection of that mix was that it was about one of this sand cement, three of sand, and about six of broken stone, and then about four parts of these plums, so that there was a very substantial bulk of these plums went into the work. The cost of putting them there may have been small. I remember how they did it; the gravel was picked up with a steam shovel, run in on cars, and dumped on grizzlies, the grizzlies being iron bars spaced a few inches apart; the plums, or cobbles, were automatically separated and run into a bin by themselves. The cobbles from this bin were loaded on to other cars, and hauled to the dam. Here is one statement of results for the month of April, 1,112 skips of plum rock at $1.50 a cubic yard; 1,668 cubic yards out of a total of 45,700. I mean by that that there 5531

was about one-thirtieth of the volume of the dam made up of these plums, which would be about 3%.

My mixing cost for the Crystal Springs Dam I assumed at $1.

Mr. Hazen: That was the unit that I assumed also. I think there is this difference, that Mr. Lippincott assumed that the forms were included in the $1, and I assumed that they were not included.

Mr. Dillman: My cost did not include forms.

CROSS EXAMINATION BY MR. SEARLS.

On stripping my dam site I allow $1.50. Stripping is a process of going over the dam site and removing all the earth and loose rock that occurs above the foundation, and on the abutment of the dam. It includes, also, the excavation down to the rock foundation. That,
5532 in some instances, is very expensive, and in others it is not. The $2 refers to the excavation down to the solid rock, and into the rock. The $1.50 figure may appear high, but the reason for it is that it is usually wet work, and the company, by pumping, and the material has to be taken out in detail and excavated by slow process. At the Gibralter Dam, where the figure was $3.14, that was sand and gravel that was full of water, with a stream to contend with. I did not expect to find the conditions as bad as that at Crystal Springs. I would expect to find some water there, as there was about 11,000 yards of material to come out. I am going quite a little on experi-
5533 ences I have had with these things that have been a bit discouraging. These bids on the Roosevelt Dam varied from 75 cents to $7.50 for that class of work. At Roosevelt you had a river to contend with, and floods that twice got down into the pits and refilled them with sand, mud and gravel. The matter of flood control was quite an element at Santa Barbara, and I would not expect to find that element present quite so much at Crystal Springs.

On page 17, the figures as to trenching excavation are for the sinking of the trench that subsequently was filled with concrete, and that relates to the Howard Cut. I think that the trench went down about 40 feet, and it had to be shored up with lagging, I believe, and that class of work is expensive.

Mr. Hazen: The figure I used in that estimate was $4.

Mr. Lippincott: If we went down 40 feet, I would expect to have some water.

Questioned by Master.

5534 I have never had to do with the putting down of but one shaft in solid rock, and I was guided to quite an extent by that on the north portal of the Elizabeth Tunnel, and the shaft was sunk 197 feet deep, 5 feet by 9 feet, approximately 1.67 cubic yards per lineal foot. That is a theoretical excavation. The direct cost on this shaft was $63.20 a foot, and the indirect cost amounted to 25%, or $15.80, making a total cost per foot of $79 for that shaft. The $79 divided by 1.67

cubic yards made $47.30 per cubic yard. The shaft at the Crystal Springs Dam was much larger, and the ratio of so much per cubic yard would not apply when you have a larger shaft. That is, the cost per yard comes less, and I arbitrarily assumed that while our shaft at Elizabeth Tunnel cost $79 a foot, that this shaft which was not so deep might be put down for $100 a foot, even though it was very much larger. Assuming $100 a foot, and 7.4 cubic yards to a lineal foot of the shaft, I arrived for the purpose of complying with the form of the estimate at a cost of $13.50 per cubic yard. The dam tunnel at Crystal Springs is the only tunnel on which I figured as brick lined, and I never put a yard of brick in a tunnel in my life, and am willing to admit that my figures on brick are purely estimates based on the best information I could get. I have used 5 barrels of sand, and 2½ barrels of cement per thousand of brick. A thousand of brick will practically make 2 cubic yards, so it is about the same amount of cement used in a yard of brick work that is used in a yard of concrete work. It is my understanding that that was what was used in this particular job. 5535

Mr. Metcalf: Doesn't it run, Mr. Dillman, about .8 of a barrel on a 1 to 3 mix, and about a little over a barrel on a 1 to 2 mix of cubic yards of masonry in place?

Mr. Dillman: It depends entirely on the thickness of the joint; a half a barrel of cement to a yard of brick work is enough.

Mr. Metcalf: I have never been able to do that.

Mr. Hazen: I have never been able to do it. I have never had less than .8 of a barrel per cubic yard with a 1 to 3 mixture, and about 50% more with a 1 to 2 mix.

Mr. Lippincott: In these estimates of the tunnels throughout the Peninsula that I have made I have used concrete. This is quite a small amount of brick, and I did not figure it over again. The brick work is beautiful work.

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Screen Tank trestle, cost of carpenters and labor (Lawrence)			5330	1437
BAKER IRON WORKS				
Lacey Bros.' figures lower (Dockweiler).....	4622	1239		
Lacey Bros.' prices on iron lower (Dockweiler)..	4638	1243		
Letter to Dockweiler, quotations from.....	4638	1243		
Pipe riveted, prices include dipping (Dockweiler)	4638	1243		
Quotations from letter compared with Dockweiler's prices (Dockweiler)	4668	1251		
Steel pipes, price quoted per pound (Dockweiler)	4639	1243		
BARGE AND TUGBOAT				
Dockweiler got quotations from Healy Tibbitts..	4782	1279		
Estimated cost of service, laying submerged pipe (Dockweiler)	4781–4791	1279–1282		
Healy Tibbitts table showing detailed cost of laying submerged pipe (Dockweiler)	4782–4783	1279–1280		
BELLS				
Weight, actual, on submerged pipe more than shown in agreed schedule (Hazen).....			4776	1278

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
BENCHING				
Description of (Dillman)	5025	1350		
Old dams, Dockweiler makes no allowance	5059	1361		
Pilarcitos Dam, no allowance made for in appraisal (Herrmann)			4987	1340
Pilarcitos Dam, shows character of material (Herrmann)			5136	1383
BENDS				
Alameda Pipe Line, cost of (Hazen)			4341	1155
Cost of (Dockweiler)	4656	1248		
Dorwood's figures do not include	4928	1319		
Portland, Ore., pipe line, cost of (Hazen)			4341	1155
BENDS AND MANHOLES				
Classed as auxiliaries, always kept separate (Hazen)			4504	1205
Classed as part of pipe (Hazen)			4500	1204
San Andres pipe line, cost of (Hazen)			4341	1155
BEVELING				
Dockweiler would require in specifications	4610	1235		
BIDS				
Dillman's experience with	4481–4482	1197–1198		
Los Angeles Water Dept. on 30" steel pipe (Dockweiler)	4454	1191		
Meters on Haywards job (Dillman)	4482	1198		
Obtained from minutes of Spring Valley Water Co. (Dockweiler)	4470	1195		
	4656	1248		
Pipe riveted, Lacey Mfg. Co. (Dockweiler)	4798	1284		
Pipe rivteted, Llewellyn Iron Works at San Diego (Dockweiler)	4798	1284		
Pipe riveted, Reitter-Connolly Mfg. Co., San Diego (Dockweiler)	4471	1195		
Pipe riveted, Schaw-Ingraham-Batcher on 44" (Dockweiler)	4471	1195		
Pipe riveted, Schaw-Batcher on explained (Hazen)			4471–4472	1195–1196
Pipe riveted, Union Iron Works on 44" (Dockweiler)	4471	1195		
Pipe riveted, Western Pipe & Steel Co., on San Diego pipe (Dockweiler)	4797	1284		
Quotations are cut in them (Dillman)	4482	1198		
Quotations usually higher than (Dockweiler)	4478	1197		
Rip rap, Modesto Irrigation District (Herrmann)			5356	1443
Sacramento City, received by on riveted steel and cast iron pipe (Dockweiler)	4473	1196		
	4475	1197		
San Diego, record of those submitted (Dockweiler)	4672	1252		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
BIDS—Continued.				
San Diego, specifications upon which based (Dockweiler)	4672	1252		
Sometimes run above preliminary estimates when based on specifications (Hazen)			4567	1223
Stripping, Roosevelt Dam (Lippincott)			5533	1500
Submerged pipe 22" was laid in rush, therefore bid was high (Dockweiler)	4785	1281		
Wild Horse Dam, Dillman bid 30c a yard but was not lowest bidder (Dillman)	5011	1347		
BLASTING				
San Fernando method of in steam shovel pit (Dockweiler)	5198	1401		
BLOCKS				
Crystal Springs Dam, method of building (Hazen)			5439	1471
BLUE LAKES				
Embankment construction method of (Ellis)	5255	1419		
Embankment cost greater than Tabeaud (Ellis)	5255	1419		
BOARD				
Figured at 71c a day in 1903 for workmen (Lawrence)			5339	1439
BOILER MAKERS				
Wage reduction in 1913 is an error in the exhibit (Lawrence)			5344	1441
BOILER MAKERS STANDARD				
Dillman did not use	4647	1258		
BONDS				
Modesto District work partly paid for in bonds (Herrmann)			5142	1385
BORDEN BROOK DAM (SPRINGFIELD, MASS.)				
Construction compared to Pilarcitos and San San Andres Dams (Hazen)			5083	1367
Construction, general description of and material used (Hazen)			5083–5085	1367–1368
Construction, method of (Hazen)			4947	1323
Contract price for embankment (Hazen)			4946	1323
Cost per cubic yard (Hazen)			4946	1323
Labor cost, etc. (Hazen)			5087	1368
BORROW PIT				
Described (Herrmann)			4975	1335
Pilarcitos Dam, discussion in re Ebright's information as to location			5400	
Pilarcitos Dam, information as to location furnished Dockweiler by Ebright	5399	1458		
Pilarcitos Dam, location of (Dockweiler)	5053–5054	1359–1360		
	5197	1401		
Pilarcitos Dam, location of did not influence Ellis' figures	5237	1414		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
BORROW PIT—Continued.				
Stripping cost of, at Calaveras (Herrmann)			5122	1379
Tabeaud Dam, general remarks (Ellis)	5251–5252	1418		
Tabeaud Dam, location of (Ellis)	5243	1416		
Wild Horse Dam No. 2 (Vallejo, Cal.) description of (Noyes)	5274	1425		
Wild Horse Dam No. 2 (Vallejo, Cal.) length of haul from (Noyes)	5270	1424		
BOSTON				
Details of 1911 job (Hazen)			4510	1207
BREAKS				
Earth dams, reasons for failure (Hazen)			5183	1397
Earth dams, reasons for failure (Dockweiler)	5182	1397		
BRICK				
Albany, N. Y., description of (Hazen)			5449	1474
BRICK LAYING				
Brick harder to lay in cement than in common mortar (Hazen)			5452	1476
Proper method of (Hazen)			5451	1475
BRICKWORK				
Albany, N. Y., description of brick used (Hazen)			5449	1474
Albany, N. Y., trouble with Bricklayers' Union (Hazen)			5449	1475
Brick harder to lay in Portland cement than in common mortar (Hazen)			5452	1476
Brick, proper way of laying (Hazen)			5451	1475
Costs, difference in (Herrmann)			4988	
Cost of, estimated units (Hazen)			5452	1476
Crystal Springs Dam, cement required (Lippincott)			5534	1500
Crystal Springs Dam, estimated unit cost of (Hazen)			5448	1474
Crystal Springs Dam, quantities and unit cost of (Hazen)			5409	1459
Derleth report, extract on Spring Valley brickwork from Engineering News (Hazen)			5453	1476
Estimates, in instances based on cost of concrete (Hazen)			5452	1476
Herrmann's estimated prices made independent of (Hazen)			4989	1340
Tunnels, Crystal Springs Dam assumed by Lippincott at $50 per M.			5485	1486
Tunnels, Crystal Springs Dam cement required (Lippincott)			5534	1500
Tunnels, Crystal Springs Dam, Lippincott figured on brick lined tunnels			5534	1500
Tunnels, Lippincott figured brick in Crystal Springs Dam only			5485	1486

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
BRIDGES				
Bridge as substitute for present Crystal Springs Upper Dam (Hazen)			5105	1374
BROOKLYN, N.Y.				
Cost of riveted pipe lines (Hazen)			4364–4365	1164
BROWN, CALVIN				
Extracts from report on Pilarcitos site (Ellis)	5253	1419		
BRUSH				
Wild Horse Dam No. 2 (Vallejo, Cal.) character of (Noyes)	5269	1424		
BUILDINGS				
Agreement between Hazen, Dillman and Dockweiler	4822	1291		
Estimates of various engineers compared			5346	1441
Pleasanton Ranch, not used nor useful (Dillman)	5347	1441		
Value of Dillman, Dockweiler and Hazen	4822	1291		
Values—Pleasanton Ranch house valued at $135,000 (Dockweiler)	4823	1241		
Values—should be on a real estate basis (Searls)	4822–4823	1291		
Values—the comparative figures were segregated from the exhibits and are comparable (Metcalf)			4824	1291
Values—what Dockweiler includes	4823	1291		
BULL RUN PIPE LINE (PORTLAND, ORE.)				
Dillman asked to compute cost per foot of	4942	1322		
Dillmann knew of	4825	1291		
Excavation, cost of first line 1894—comparatively second line 17 years later much greater (Hazen)			4509	1206
Excavation, cost grubbing was not included in (Hazen)			4507–4508	1206
Excavation details of (Hazen)			4507–4508	1206
Excavation, Hazen familiar with trench conditions			4507	1206
Grubbing very heavy in trench excavation (Dillman)	4508	1206		
CABLES				
Dockweiler estimated on one in laying submerged pipe	4793	1283		
CALAVERAS DAM				
Cement, price paid for at Calaveras, 1914 (Lippincott)			5520	1497
Clearing, cost of, reservoir site (Herrmann)			4965	1331
			5118	1379
Clearing, cost of, roads and trails (Herrmann)			5118	1378
Clearing, method of estimating cost (Herrmann)			5119	1379
Construction, methods of (Herrmann)			4977	1336
(Hazen)			5109	1375
Construction, not comparable to Pilarcitos (Hazen)			5109	1375
Construction, some of the work done in a rush (Herrmann)			5145	1386
Costs, Hazen familiar with			4957	1328

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
CALAVERAS DAM—Continued.				
Costs, unit (Herrmann)			4973	1334
Equipment, capacity adequate (Hazen)			5152	1388
Equipment, Spring Valley Water Co. used capacity of (Hazen)			5152	1388
Fill, cost of (Hazen)			5110	1375
Fill, cost of material placed, steam shovel (Herrmann)			5143	1385
Hauling, cost of material from steam shovel (Herrmann)			4966–4967	1332
Hauling for flume, based on Calaveras experience (Herrmann)			5368	1447
Labor, work 10 hours a day (Herrmann)			4964	1331
Litigation, work retarded by (Herrmann)			5149	1387
Loading and operating wagons, methods of (Elliott)			5391	1455
Material, compacting of (Elliott)			5391	1455
			5395	1456
Materials used in reproduction (Elliott)			5398	1457
Power, cost of (Herrmann)			5122–5123	1379
Power, cost of plant (Herrmann)			5123	1379
Resume of work at (Elliott)			5394	1456
Steam shovel, capacity of (Herrmann)			4978	1336
Steam shovel, conditions not as good as at Franklin and San Fernando Dams (Elliott)			5386	1453
Steam shovel, cost of moving (Herrmann)			4989	1340
Steam shovel, cost of operating (Herrmann)			4979	1337
Steam shovel, cost of transporting (Herrmann)			4978	1336
Steam shovel, cost of work (Herrmann)			4970	1333
Steam shovel, method of operating (Herrmann)			4978	1336
Steam shovel, percentage of time lost			5145–5148	1386–1387
Steam shovel, present cost of (Hazen)			5110	1375
Steam shovel work, actual cost estimate (Elliott)			5384–5387	1453–1454
Steam shovel work compared with Pilarcitos (Elliott)			5397	1457
Steam shovel work, Elliott had advantage of Mulhollands' and other engineers' advice			5387	1454
Steam shovel work, very difficult (Elliott)			5386	1453
Stock, rental cost of (Herrmann)			5140	1384
Spring Valley Water Co. cared for and fed stock (Herrmann)			5141	1384
Stripping by hydraulic process, estimate of (Herrmann)			4967	1332
Stripping, cost of (Herrmann)			4966	1331
			5122–5123	1379
Stripping, cost of at borrow pit (Herrmann)			5122	1379
Stripping of Freeman site rushed (Herrmann)			5151	1388
Teams, cost of (Herrmann)			5315	1434
Teamsters, wages of (Herrmann)			5315	1434

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
CALAVERAS DAM—Continued.				
Trenching, cost of (Herrmann)			4983	1338
			5155	1389
Water supply (Herrmann)			5115–5116	1377
CALAVERAS RESERVOIR				
Clearing cost of (Herrmann)			4965	1331
			5118	1379
Floods, will conserve (Hazen)			4277	1133
Stripping, cost of (Herrmann)			4966	1331
CALAVERAS SUNOL ROAD				
Clearing, cost of (Herrmann)			4964	1331
Clearing, cost 15% less than Pilarcitos reservoir (Herrmann)			4965	1331
CAPACITIES				
New Era Grader and steam shovel compared (Noyes)	5293	1429		
Of New Era Grader (Dillman)	5288	1428		
Of steam shovel dipper at Calaveras is right (Hazen)			5152	1388
Pipes of Spring Valley riveted (Hazen)			4314–4315	1144–1145
Pipes of Spring Valley steel (Hazen)			4314–4315	1144–1145
Pipes steel when new would have greater capacity than old wrought iron pipes of Spring Valley (Hazen)			4370	1166
Pipes, steel would have to be of greater diameter to have capacity as wrought iron pipe (Hazen)			4367	1165
Pipes, wrought iron of Spring Valley 13 to 14% greater than steel pipe (Hazen)			4367	1165
Steam shovel (Dillman)	5288–5289	1428		
	5294–5295	1429		
Steam shovel at Franklin Canyon (Dockweiler)	5192	1400		
Steam shovel for embankment work (Dillman)	5014	1348		
Steam shovel Pilarcitos, assumed by (Dillman)	5171	1394		
Steam shovel Pilarcitos, assumed by (Dockweiler)	5208	1404		
Steam shovel worked on a 260 day per year efficiency basis (Dockweiler)	5210	1404		
CAREY, MR.				
Submerged pipe, Lawrence says 20 foot lengths as given in Carey's testimony is not true			5324	1436
Testimony, quotations from in 1904 in re dipping riveted pipe (Lawrence)			5323	1436
CARPENTERS				
San Andres pipe line, work on explained (Lawrence)			5303	1432
Trestle, cost of on Baden screen tank trestle (Lawrence)			5330	1437
Wages of (Lawrence)			5306	1432
Wages of, on riveted pipe jobs (Lawrence)			5328	1437

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
CARTAGE				
Iron riveted and freight (Dockweiler)	4656	1248		
CAULKING				
Akron, O., contract price for delivery of pipe at trench including riveting, etc. (Hazen)			4338	1153
Bevelling not done unless specified (Dockweiler)	4610	1235		
California methods inferior to Spring Valley practice (Hazen)			4348	1157
Cost of (Dockweiler)	4644	1245		
Data on (Dockweiler)	4643	1245		
Dockweiler obtained data from Francis Smith yard on cost of	4645	1245		
Equipment for field work would cost (Dockweiler)	4646	1246		
Flumes, estimated cost of (Herrmann)			5372	1449
Flumes in Sierras not ordinarily caulked (Herrmann)			5372	1449
Hewson in Montague's shop furnished data (Dockweiler)	4644	1245		
Inside, is more important than outside caulking (Dillman)	4714	1263		
Inside, not done on light weight iron (Dockweiler)	4641	1244		
Inspection, Pacific Coast practice cannot be taken as standard for cost without proper inspection (Hazen)			4350	1158
Lacy Bros. no provision for inside and out (Dockweiler)	4618	1238		
Los Angeles, contract price including delivery at trench and riveting, etc. (Hazen)			4338	1153
Method employed on Pacific Coast (Hazen)			4350	1158
Never heard of running bran through pipe to make caulking tight (Hazen)			4761	1273
Portland, Ore., cost of, including riveting ¼" plate in trench (Hazen)			4495	1202
Portland, Ore., contract price, including riveting and delivery at trench (Hazen)			4338	1153
Process of (Dockweiler)	4647	1246		
Risdon Iron Works, Dockweiler observed costs	4640	1244		
Riveted pipe, samples of, Spring Valley explained (Hazen)			4358–4361	1162–1163
Steel pipe of Monterey Water Co. method of (Rhodes)	4751	1270		
Two kinds, ordinary and split (Dockweiler)	4619	1238		
Wages of a caulker (Dockweiler)	4645	1245		
Would not allow (Dockweiler)	4619	1238		
Wrought iron is worked easier than steel (Dillman)	4413	1179		
CEMENT				
Brick work, tunnels at Crystal Springs amount required (Lippincott)			5534	1500

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
CEMENT—Continued.				
Cost of at Colton (Lippincott)			5517	1496
Cost of at Los Angeles (Lippincott)			5471–5473	1481–1482
Cost of, estimated at San Mateo (Lippincott)			5471–5474	1481–1482
Cost of manufacture (Lippincott)			5471	1481
Cost of, Mojave (Lippincott)			5517B	1496
Cost of, Mojave and Colton (Lippincott)			5517B	1496
Cost of, Santa Barbara (Lippincott)			5470	1481
Cost of, Spaulding (Lippincott)			5520	1497
Cost of manufacture would be more near San Francisco than in East (Hazen)			5428	1467
Cost of on Eastern dams (Hazen)			5427	1467
Crystal Springs Dam, amount required for brickwork (Lippincott)			5534	1500
Crystal Springs Dam, cost of (Hazen)			5414–5428	1461–1467
Crystal Springs Dam, percentage of bags that could be returned (Hazen)			5414	1461
Crystal Springs Dam, quality of (Hazen)			5415	1462
Gibraltar Dam, cost of (Lippincott)			5516	1495
Kensico Dam (N. Y.) paid for as extra (Hazen)			5421	1464
Manufacture, cost of at Oro Grande does not include selling cost (Dockweiler)	5430	1468		
Manufacture, cost of at Oro Grande 68c per barrel (Dockweiler)	5429	1468		
Manufacture, costs 68c per bbl. to manufacture in San Francisco (Dockweiler)	5428	1467		
Manufacture, Dockweiler's prices do not cover depreciation (Lippincott)			5473	1482
Prices higher at Riverside than at Los Angeles (Lippincott)			5521	1497
Prices of at San Mateo (Hazen)			5523	1498
Price paid by Los Angeles in 1914 (Lippincott)			5518	1497
Price paid for use at Calaveras in 1914 by Spring Valley Water Co. (Lippincott)			5520	1497
Selling cost, there is a combination in (Lippincott)			5469	1480
Spaulding Dam, cost of (Hazen)			5432–5433	1468–1469
Stockton St. Tunnel, San Francisco, price paid (Ellis)	5522	1498		
CEMENT BAGS				
Percentage that could be returned (Hazen)			5414	1461
CEMENT—TUFA				
Blending, cost of on Los Angeles Aqueduct (Lippincott)			5517A	1496
CENTRAL IRON WORKS				
Total tonnage and age of puddled and charcoal iron plates made by, for Spring Valley Water Co. (Hazen)			4310	1143

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
CENTRAL RESERVOIR DAM, OAKLAND				
Dockweiler familiar with	5029	1352		
Dockweiler has detail costs complete	5032	1353		
Embankment was rolled (Dockweiler)	5763	1392		
Number of days worked and elapsed time for steam shovel work (Dockweiler)	5188	1399		
Puddle core, described (Dockweiler)	5200	1402		
Puddle core, not above the surface (Dockweiler)	5163	1392		
Steam shovel carries four men on payroll whether it works or not (Dockweiler)	5189	1399		
Steam shovel, rental of and wages of crew (Dockweiler)	5040	1355		
Steam shovel, size of, used on (Dockweiler)	5186	1398		
Steam shovel, work data from records of Peoples Water Co.	5039	1355		
Steam shovel work, record of (Dockweiler)	5201	1402		
Steam shovel work supporting data from Dockweiler's estimate of 900 yards per day at Pilarcitos	5202	1402		
Steam shovel, worked on, 139 days out of 212 (Dockweiler)	5044	1356		
Trench described (Dockweiler)	5200	1402		
Wilhelm in charge of construction (Dockweiler)	5203	1403		
CHART (DILLMAN'S)				
Dillman thinks nearer truth than Hazen formula	4703	1260		
Is possible Spring Valley pipes will not measure in weight with (Dillman)	4704	1260		
CHELSEA CREEK				
Pipe, submerged, method of laying not similar to Spring Valley system			4847	1298
Pipe, submerged, would require less equipment than Spring Valley (Metcalf)			4848	1298
CHENERY ST.				
Riveted pipe might have been pipe Mr. Moebus referred to as having been laid by Francis Smith & Co. (Metcalf)			5019	1349
Riveted pipe, not under much pressure (Herrmann)			5020	1349
CHIPPING				
Method used (Dockweiler)	4640	1244		
CITY DISTRIBUTION SYSTEM				
Concrete cost less than on Peninsula and Alameda work (Hazen)			5442	1472
Concrete, cost of (Hazen)			5442	1472
CLEANING				
Pipe riveted, Dockweiler observed cost, Risdon Iron Works	4640	1244		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
CLEARING				
Cost, average in East (Hazen)			4954	1327
.....			5099	1372
Cost of, bottom land estimated (Herrmann)			4963	1330
Cost of, Calaveras Dam site (Herrmann)			5118	1378
Cost of, Calaveras Reservoir site (Herrmann)			4965	1331
Cost of, Calaveras Sunol road (Herrmann)			4964	1331
Cost of, Colorado River levees (Herrmann)			4963	1330
.....			5121	1379
Cost of, for roads and trails at Calaveras Dam (Herrmann)			5118	1378
Cost of, San Andres Dam (Hazen)			4953	1326
Cost of, stripping Calaveras borrow pits (Herrmann)			5122	1379
Earth Dams, unit costs (Dillman)	5013	1347		
Eastern costs applied generally to California conditions (Hazen)			5099	1372
Eight hour day used on basis in estimating on earth dams (Hazen)			5100	1372
Hetch-Hetchy about $35 per acre (Searls)	5101	1373		
Hetch-Hetchy contract includes portion where there is no growth (O'Shaughnessy)	5101	1373		
Hillside for earth dams, estimated cost of (Herrmann)			4963	1330
Hours of labor in East (Hazen)			5100	1372
Labor, hours, etc., employed in clearing for earth dams (Hazen)			5100	1372
Method of estimating cost of, Calaveras Dam (Herrmann)			5119	1379
Method of estimating cost of stripping Pilarcitos Dam (Herrmann)			5124–5125	1379–1380
Method of stripping for earth dams (Herrmann)			5122	1379
Pilarcitos Reservoir costs 15% more than Calaveras Sunol Road (Herrmann)			4965	1331
Rate paid for labor on earth dams (Hazen)			5100	1372
Unit cost of, for eath dams (Herrmann)			4963	1330
Wages paid for labor on earth dams (Hazen)			5099	1372
Wild Horse Dam No. 2 (Vallejo, Cal.) contract price for (Noyes)	5269	1424		
Wild Horse Dam No. 2 (Vallejo, Cal.) cost of (Noyes)	5269	1424		
CLIMATE				
Comparison of, at Imperial Valley and Pilarcitos Dam (Herrmann)			4971	1333
COATING				
Albany, New Bedford and Washington lines not as good as Spring Valley dip (Hazen)			4546	1216

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
COATING—Continued.				
Asphaltum sheet "P 7" Lawrence's analysis shows cost of, for wrought iron pipe (Lawrence)			4399	1175
Coal tar mixed with the asphalt in the Spring Valley dip resulted in an excellent mixture (Hazen)			4546	1216
Cost of (Dockweiler)	4651	1247		
	4655	1248		
Cost of Schussler formula for figuring (Lawrence)			4399	1175
Dorward's figures do not include dipping	4928	1319		
Lawrence analysis shown on sheet "P 5"			4398	1174
Life and condition of Spring Valley pipes due to (Dillman)	4415	1179		
Life of pipe depends most on (Dillman)	4414–4415	1179		
Los Angeles syphon pipe not dipped but painted (Hazen)			4555	1218
New Bedford, Albany and Washington steel pipe lines dipped with asphalt (Hazen)			4545	1215
New Bedford riveted pipe (Hazen)			4543	1215
Of Spring Valley better than Sacramento pipe job (Ellis)	4812	1288		
Park line does not compare with Spring Valley asphaltum coating (Metcalf)			4524	1210
Rental of kettles was in addition to Risdon contract price on Spring Valley riveted pipe (Dorward)	4910	1314		
Riveted pipe, cost .008c per lb. (Lawrence)			4398	1174
Riveted pipe, proportion one part coal-tar, three parts asphaltum (Lawrence)			4398	1174
Spring Valley coating the best in U. S. (Dockweiler)	4527	1211		
Spring Valley thicker than is put on in any other part of the U. S. (Dockweiler)	4527	1211		
Weight, actual in Spring Valley Water Co.'s system (Hazen)			4333	1152
Weight of, on pipe runs close to loss of metal in manufacturing (Hazen)			4337	1153
Weight of, on Spring Valley riveted pipe equals 9.4% of metal (Hazen)			4343	1155
Wrought iron has no advantage over steel as long as coating is intact (Dillman)	4415	1179		
Coating, see also dipping				
COLMA DAM				
More costly than San Mateo Dams (Hazen)			4956	1328

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COLORADO RIVER				
Clearing cost of levee sites (Herrmann)			4963	1330
.....			5121	1379
COLUMBUS, O. DAM				
Description of (Hazen).....			5424	1465
COMPACTING				
Earth dams, Dockweiler considers necessary....	5199	1402		
COMPARISONS				
Argonaut pipe line, comparable to Spring Valley (Ellis)	4887	1308		
Contra Costa Water Co., Dockweiler's estimate for backfilling, laying, hauling and distributing are comparable to Mr. Adams'.....	4681	1253		
Dockweiler's units at San Andres compared with Hazen's and Herrmann's.....	5072	1365		
Excavation riveted pipe, unit prices of Ellis compared to Hazen.....	4998	1342		
In labor efficiency for 8 and 10 hour day (Ellis)	5233	1413		
Laying, Dockweiler costs and costs in Schaw-Batcher Co.'s letter for 44" pipe.....	4663	1249		
Pleasanton line not comparable to other pipes in Spring Valley system (Dockweiler)	4603	1234		
Unit costs of San Andres compared to those at Pilarcitos Dam (Dockweiler).....	5066	1363		
Vallejo Dam is just as good as San Leandro Dam (Dillman)	5181	1396		
Weights, Dillman's compared to Hazen's and Dockweiler's (Dillman)	4700	1259		
COMPRESSOR				
Power required to drive, in the manufacture of steel pipe for Monterey Water Co. (Rhodes)..	4753	1271		
COMPRESSOR HOSE				
Dockweiler does not know how it is made.....	4648	1246		
COMPUTATIONS				
Dockweiler did not make any on time steam shovel worked on Central Reservoir, Oakland	5041			
CONCRETE				
City Distribution System, cost less than Peninsula and Alameda work (Hazen).....			5442	1472
City Distribution System, cost of (Hazen).....			5442	1472
Cost estimated, in balance of Crystal Springs Dam system (Hazen).....			5440	1471
Cost of, at government dams (Lippincott).....			5529	1499
.....			5530	1499
Cystal Springs Dam, comparison of costs (Hazen)			5443	1472
Crystal Springs Dam, cost less than in Alameda system (Hazen)			5441	1471
Crystal Springs Dam, cost of auxiliary structures (Hazen)			5417	1462

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CONCRETE—Continued.				
Crystal Springs Dam, cost of does not include rock crushing plant (Hazen)			5418	1463
Crystal Springs Dam, cost of in place (Hazen)			5417	1462
..			5418	1463
Crystal Springs Dam, cost of labor (Hazen)			5418	1463
Crystal Springs Dam, estimated cost of (Lippincott)			5483	1485
Crystal Springs Dam, Hazen assumed modern method for mixing and placing			5418	1463
Crystal Springs Dam, mix assumed in appraisal (Lippincott)			5468	1480
Crystal Springs Dam, mix used (Lippincott)			5334	1438
Crystal Springs Dam, mixing, estimated cost of (Lippincott))			5531	1500
Crystal Springs Dam, quantities and unit costs of (Hazen)			5409	1459
Crystal Springs Dam, will cost more than similar work elsewhere (Hazen)			5420	1464
Frames, part of cost (Dillman)	5168	1393		
Government Dam, cost of on (Lippincott)			5479	1484
Government Dam, mixed used (Lippincott)			5528	1499
			5530	1499
Hauling, total cost per cubic yard Crystal Springs Dam			5419	1463
Lippincott assumes most modern methods in concrete work			5482	1485
Lippincott's proposed method of mixing and placing			5482	1485
Material, cost of, Crystal Springs Dam (Hazen)			5919	1463
Mixing and placing, cost of (Lippincott)			5479	1484
Mixing and placing, cost of at Crystal Springs (Lippincott)			5481	1484
Mixing and placing, cost of, Gibraltar Dam, Santa Barbara (Lippincott)			5481	1484
Sunol Filter Galleries, estimated cost of (Hazen)			5441	1471
Tunnels at Crystal Springs, Lippincott assumed concrete in reproduction			5534	1500
Unit cost, in puddled trench (Herrmann)			4986	1340
Unit cost on dams (Dillman)	5025			
	5028			
Unit prices for, Pilarcitos Dam (Dockweiler)	5057	1361		
CONNECTICUT RIVER PIPE LINE				
Cost of (Hazen)			4828	1292
Laid differently from Spring Valley submerged pipe (Hazen)			4827	1292
Length of (Hazen)			4827	1292
Steel (Hazen)			4828	

	Defendant		Plaintiff	
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CONSTRUCTION				
Alamo Dam methods used (Herrmann)			5140	1384
Blocks, Crystal Springs Dam, method of building (Hazen)			5439	1471
Borden Brook Dam (Springfield, Mass.) (Hazen)			5083–5085	1367–1368
Borden Brook Dam, compared to Pilarcitos and San Andres (Hazen)			5083	1367
Borden Brook Dam, methods used (Hazen)			4947	1323
Calaveras Dam, methods used (Herrmann)			4973	1334
(Hazen)			5109	1375
Calaveras Dam, resume of work (Elliott)			5394	1456
Central Reservoir, Oakland, was under charge of Geo. Wilhelm	5203	1403		
Crystal Springs Dam, magnificent piece of masonry (Hazen)			5436	1470
Crystal Springs Dam, method used best practice at present time (Hazen)			5418	1462
Crystal Springs Dam, went through earthquake without injury (Hazen)			5418	1463
Difference between Pilarcitos and Calaveras Dams (Hazen)			5109	1375
Drum Forebay, method of (Herrmann)			5127	1380
Earth Dams by hydraulic fill method (Hazen)			4958	1328
Earth Dams, general remarks on construction of (Hazen)			4945	1322
Ellis familiar with Tabeaud Dam	5224	1409		
Embankments, proposed method (Ellis)	5239	1415		
Flumes, methods used by Spring Valley Water Co. (Lawrence)			5375	1450
Gibraltar Dam, Santa Barbara, method of (Lippincott)			5516	1495
Hazen estimates 2 years to reproduce Pilarcitos and San Andres dams by his method			5083	1367
Hazen has made estimates for contemplated construction for Spring Valley Water Co.			4514	1208
Lake Arthur Dam, materials used in (Herrmann)			5138	1383
Los Angeles Aqueduct dams not comparable to Pilarcitos dams (Herrmann)			5114	1376
			5115	1377
Los Angeles aqueduct not being done cheaper than Hazen's method (Hazen)			4957	1328
Method of Franklin Canyon Dams (Dockweiler)	5194	1400		
Method of on embankment of Blue Lakes (Ellis)	5255	1419		
Methods assumed in estimating construction of earth dams (Herrmann)			4974	1335
Methods of separting material for earth dam embankments (Hazen)			5096	1371

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
CONSTRUCTION—Continued.				
Pacific Coast more expensive than on Atlantic (Hazen)			4294	1139
			4295	1140
Pilarcitos Dam, date of (Herrmann)			4990	1341
Pilarcitos Dam, method of (Hazen)			5109	1375
Pilarcitos Dam, proposed method (Elliott)			5390	1454
Pilarcitos Dam, proposed method of reproduction (Ellis)	5232	1412		
Pilarcitos Dam, unit cost (Herrmann)			4976–4977	1335–1336
Pilarcitos Dam, would be built differently than Calaveras (Hazen)			5109	1375
Plums not available at Crystal Springs Dam (Hazen)			5439	1471
San Andres Dam, proposed method of reproduction (Ellis)	5232	1412		
San Andres Dam, unit cost (Herrmann)			4976–4977	1335–1336
Tabeaud Dam, method of (Ellis)	5224	1409		
CONSTRUCTION CAMPS				
Usually maintained for men on large jobs (Lawrence)			5317	1435
CONSTRUCTION, NEW				
Amount required to bring plant up to present need (Hazen)			4280–4284	1134–1136
CONTINGENCIES				
Overhead, explanation of (Hazen)			5511	1494
Riveted pipe, 10% added to excavation for (Hazen)			4356	1161
CONTRA COSTA WATER CO.				
Cost of, explanation of Adams' notes (Dockweiler)	4800	1285		
Costs, Dockweiler prepared data obtained from Arthur L. Adams (Dockweiler)	4679	1253		
Dillman does not know fabrication cost of line built by him	4687	1255		
Dockweiler's estimates for backfilling, laying, hauling and distributing are comparable to Mr. Adams' figures	4681	1253		
Explanation Deft. Exhibit 100m (Dockweiler)	4800	1285		
Memoranda and original figures received from Mr. Adams (Dillman)	4727	1266		
Pipe line built by Dillman, fabricated by Risdon Iron Works	4686	1255		
Pipe line built by Dillman, not less than 16"	4686	1255		
Pipe line built by Dillman leaked	4686	1255		
Trenching and backfilling 45c (Dockweiler)	4801	1285		

	Defendant		Plaintiff	
CONTRACTORS	Record	Abstract	Record	Abstract
Alameda pipe line in 1898, went broke (Lawrence)			5333–5336	1438–143
Profit on submerged pipe should be more than 20% (Hazen)			4835	1294
CONTRACTS				
Borden Brook Dam, contract price for embankment			4946	1323
Contract price from Schaw-Batcher on Park Line 87c per foot (Hazen)			4536	1213
Dockweiler assumed that work would be done by.	4432	1184		
Emory contract on Pilarcitos Dam discussed by Dockweiler	5104	1373		
Extract from contract for 22″ submerged pipe (Dockweiler)	4785	1281		
Lacy Bros. with Los Angeles (Dockweiler)	4452	1191		
Llewelyn Bros. with Los Angeles (Dockweiler)	4454	1191		
Los Angeles Aqueduct, no contract price for pipe fabricated and delivered (Hazen)			4561	1220
Modesto Irrigation District, price for puddling (Herrmann)			4984	1339
Oakdale Irrigation District, date of for gravity pipe (Dillman)	4734	1267		
Pipe contract prices for, in various cities (Hazen)			4337–4340	1153–1154
Prices, average for eastern dams (Hazen)			5430	1468
Submerged pipe 16″, there is a record of an old contract price (Hazen)			4771	1276
Submerged pipe 22″, cost of laying (Hazen)			4767	1274
Wild Horse Dam No. 2 (Vallejo, Cal.), term of (Noyes)	5268	1424		
CORRECTIONS				
In Lawrence's original table of cost of riveted pipe			5297	1430
In testimony			4548	1217
			5309	1433
			5311	1433
			5465	1480
In testimony of Dockweiler	4463	1194		
In testimony of Hazen			4323	1149
			4393	1172
			4986	1340
In testimony of Hazen and Metcalf			4239	1123
In testimony of Hazen in re thickness of Alameda Pipe Line			4463–4464	1194
In testimony of Herrmann, Col. 23 page 1, Exhibit 105			4962	
In testimony of Herrmann, page 5371			5381	1452
In testimony of Lawrence			4463	1194
In testimony of Lawrence, pages 5315, 5331, 5374			5381	1452

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	Record	Abstract	Record	Abstract
CORROSION				
Difference between and tuberculation (Hazen)...			4315	1145
COST				
Accessories on riveted pipe line at Albany, N. Y., above 10% (Hazen).....			4362	1163
Accessories on riveted steel pipe line at Washington much higher than 10% (Hazen).....			4362–4363	1163
Accessories on 36" Alameda pipe line shown in sheet "P 19" Lawrence's analysis (Lawrence)			4404	1176
Accessories on San Andres 44" line (Lawrence)..			4403	1176
Accessories 32" riveted pipe line at Springfield, Mass., supports Hazen's 10% for.....			4362	1163
Alameda Line, Belmont to Millbrae, unit price (Dillman)	4426	1183		
Alameda Line, 54" pipe, $9.61 per foot dipped (Dockweiler)	4668	1251		
Alameda Line, 54" and estimate by (Hazen)....			4567	1223
Alameda Line, 54" most expensive line Spring Valley has laid in recent years (Hazen).....			4567	1223
Alameda Line, 36" near Newark, and estimate by (Hazen)			4567	1223
Alameda Line, 36" through Ellsworth property Lawrence's analysis			4402	1176
Alameda Line, Ravenswood to Belmont, unit prices (Dillman)	4426	1183		
Alameda Line, unit prices (Dillman).....	4425	1182		
Backfill, unit costs (Lawrence).....			5349	1441
Baker Iron Works, figures higher than Lacy Bros. (Dockweiler)	4622	1239		
Barge and tug boat service, laying submerged pipe (Dockweiler)	4791	1282		
Bends (Dockweiler)	4656	1248		
Bends, etc., on Alameda pipe line (Hazen).....			4341	1155
Bends and manholes for riveted pipe at Portland (Hazen)			4341	1155
Bends and manholes for San Andres pipe line (Hazen)			4341	1155
Blasting per cubic yard of excavation (Herrmann)			5154	1389
Blending Tufa cement, Los Angeles aqueduct (Lippincott)			5517A	1496
Blue Lakes embankment more than Tabeaud Dam (Ellis)	5255	1419		
Board of men on pipe jobs 71c a day in 1903 (Lawrence)			5339	1439
Borden Brook Dam, total cost per cubic yard, Springfield, Mass. (Hazen).....			4946	1323
Brick, Crystal Springs tunnels, assumed by Lippincott at $50 per M.			5485	1486
Brickwork, Crystal Springs Dam (Hazen).....			5409	1459

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	Record	Abstract	Record	Abstract
COST—Continued.				
Brickwork, earth dams, difference in unit costs (Herrmann)			4988	
Brickwork, estimated units (Hazen)			5452	1476
Brickwork, estimated unit cost of Crystal Springs Dam (Hazen)			5448	1474
Calaveras Dam, Hazen familiar in general way with costs of			4957	1328
Calaveras Dam, unit cost of (Herrmann)			4973	1334
Carpenters and labor for Baden Screen tank trestle (Lawrence)			5330	1437
Caulking (Dockweiler)	4644	1245		
Caulking and riveting on Pacific Coast not standard (Hazen)			4350	1158
Caulking and tarring flumes (Herrmann)			5372	1449
Caulking, Dockweiler obtained data from Francis Smith yard	4645	1245		
Caulking equipment for field would cost (Dockweiler)	4646	1246		
Caulking, Risdon Iron Works, Dockweiler observed costs	4640	1244		
Cement, assumed at Crystal Springs Dam (Hazen)			5428	1467
Cement at Calaveras in 1914 by Spring Valley Water Co. (Lippincott)			5520	1497
Cement at Colton (Lippincott)			5517B	1496
Cement at Crystal Springs Dam (Hazen)			5414	1461
Cement at Gibraltar Dam, Santa Barbara (Lippincott)			5516	1495
Cement at Los Angeles			5471–5473	1481–1482
Cement at Mojave (Lippincott)			5517B	1496
Cement at Mojave and Colton (Lippincott)			5517B	1496
Cement at Oro Grande, 68c per barrel does not include selling cost (Dockweiler)	5430	1468		
Cement at San Mateo, estimated cost (Lippincott)			5471–5474	1481–1482
Cement at Santa Barbara (Lippincott)			5470	1481
Cement at Spaulding (Lippincott)			5520	1497
Cement can be manufactured at Oro Grande for 68c per barrel (Dockweiler)	5429	1468		
Cement costs 68c per barrel to manufacture in San Francisco (Dockweiler)	5428	1467		
Cement, manufacture of (Lippincott)			5471	1481
Cement, manufacture of would cost more near San Francisco than in East (Hazen)			5428	1467
Cement on eastern dams (Hazen)			5427	1467
Cement on Spaulding Dam (Hazen)			5432–5433	1468–1469
Cement, there is a combination in the selling of (Lippincott)			5469	1480
Central Reservoir, Oakland, Dockweiler has detail	5032	1353		

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COST—Continued.				
Clearing, average cost of in East (Hazen).....			4954	1327
Clearing, average for earth dams (Hazen).....			5099	1372
Clearing Calaveras Dam site (Herrmann).....			5118	1378
Clearing Calaveras Reservoir site (Herrmann)....			4965	1331
Clearing Calaveras Sunol Road (Herrmann).....			4964	1331
Clearing Colorado River levees (Herrmann).....			4963	1330
.....			5121	1379
Clearing earth dams (Dillman).....	5013	1347		
Clearing, eastern costs applied generally to California conditions (Hazen).....			5099	1372
Clearing, method of estimating cost of Calaveras Dam (Herrmann)			5119	1379
Clearing, Pilarcitos Reservoir costs 15% more than Calaveras Sunol Road (Herrmann).....			4965	1331
Clearing roads and trails at Calaveras Dam (Herrmann)			5118	1378
Clearing sites for earth dams (Herrmann).....			4963	1330
Clearing Wild Horse Dam No. 2 (Vallejo, Cal.) (Noyes)	5269	1424		
Coating (Dockweiler)	4651–4655	1247–1248		
Coating, Lawrence analysis Sheet "P 7".....			4399	1175
Concrete, City Distribution System (Hazen).....			5442	1472
Concrete, comparison of Crystal Springs Dam (Hazen)			5443	1472
Concrete, Crystal Springs Dam (Hazen).....			5409	1459
Concrete, Crystal Springs Dam, cost more than similar work (Hazen).....			5020	1464
Concrete, Crystal Springs Dam, does not include rock crushing plant (Hazen).....			5418	1463
Concrete, Crystal Springs Dam, estimated cost of (Hazen)			5483	1485
Concrete, estimated cost of mixing and placing at Crystal Springs (Lippincott).....			5481	1484
Concrete, estimated mixing cost at Crystal Springs (Lippincott)			5531	1500
Concrete in balance of Crystal Springs (Hazen)..			5440	1471
Concrete in City Distribution System less than Peninsula and Alameda work (Hazen).....			5442	1472
Concrete in dams (Herrmann).....			4986	1340
Concrete in Government dams (Lippincott).....			5479	1484
Concrete in place, Crystal Springs Dam (Hazen)..			5417–5418	1462–1463
Concrete less in Alameda System than in Crystal Springs Dam (Hazen).....			5441	1471
Concrete material, Crystal Springs Dam (Hazen)			5419	1463
Concrete mixing and placing (Lippincott).....			5479	1484
Concrete mixing and placing Gibraltar Dam, Santa Barbara (Lippincott)			5481	1484

COST—Continued.	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
Concrete on dams (Dillman)	5025–5028	1350–1351		
Concrete, Sunol Filter Galleries (Hazen)			5441	1471
Contra Costa Water Co., Dockweiler prepared data obtained from Arthur L. Adams	4679	1253		
Contra Costa Water Co., Dillman does not know fabrication cost of line built by him	4687	1255		
Contra Costa Water Co. work explanation of Adams' notes on (Dockweiler)	4800	1285		
Crystal Springs Dam, actual cost obtained from Wenzelburger's report (Greene)			5434	1469
Crystal Springs Dam, difference between Hazen's and Lippincott's estimates			5513	1434
Crystal Springs Dam, estimated cost today practically same as actual cost of 25 years earlier (Hazen)			5436	1470
Crystal Springs Dam, estimated for reproduction of (Metcalf)			5435	1470
Crystal Springs Dam, excavation cost of for tower (Lippincott)			5534	1500
Crystal Springs Dam, Hazen's and Lippincott's figures compared			5501–5509	1491–1493
Crystal Springs Dam, method of computing based on Eeastern experience (Hazen)			5430–5431	1468
Crystal Springs Dam, segregation of Wenzelburger's report			5434	1469
Crystal Springs Dam would be increased if joints were duplicated (Hazen)			5437	1470
Crystal Springs Dam, would cost more than similar dam favorably situated (Hazen)			5423	1465
Crystal Springs Dam (Upper), Dillman's total cost	5073–5075	1365–1366		
Crystal Springs Dam (Upper) Dillman used same unit prices as at San Andres	5027	1351		
Crystal Springs Dam (Upper), total (Dockweiler)	5073–5075	1365		
Crystal Springs Dam (Upper), total estimate (Hazen)			5073–5075	1365–1366
Crystal Springs line excavation at 50c per cubic yard (Dillman)	4423	1182		
Crystal Springs line structure 1, unit prices (Dillman)	4422	1182		
Dam, Alamo River, Imperial Valley (Herrmann)			4970	1333
Dams, at Springfield, Mass. (Hazen)			5095	1371
Difference between long and short ton would be 12% in the cost (Dillman)	4689	1256		
Difference of $101,000 between Dockweiler and Hazen on San Andres pipe line	4438	1186		
Difference in units between San Andres and Pilarcitos dams (Dillman)	5026	1351		

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	Record	Abstract	Record	Abstract
COST—Continued.				
Dillman does not care to go into detail cost of riveting	4431	1184		
Dillman estimate based on reproduction cost of wrought iron pipe	4415	1179		
Dillman formula	4851	1299		
Dillman table explained	4417	1181		
Dillman table showing weight and cost per lineal foot	4416	1180		
Dipping, not included in Dorward's figures	4928	1319		
Dipping pipe with Schussler coating, formula for figuring (Lawrence)			4399	1175
Dipping riveted pipe, agreed upon by Dockweiler and Hazen			4342	1155
Dipping, San Andres line 30" (Lawrence)			4398	1174
Dockweiler did not get any quotations from Eastern pipe houses	4622	1239		
Dockweiler has had access to the cost record of the Spring Valley Water Co.	4432	1184		
Dockweiler made no difference in the fabrication price between steel and wrought iron	4453	1191		
Dockweiler's method of estimating cost of riveted pipe	4432	1184		
Dockweiler on 34" ¼ iron dipped $6.08 per lineal foot	4668	1251		
Dockweiler's units at San Andres compared to Hazen's and Herrmann's	5072	1365		
Dockweiler used a differential of 1½c a lb. between steel and wrought iron	4452	1191		
Dorwood did not pay attention to specifications in making up cost	4895	1310		
Dredging for submerged pipe at Portland (Dillman)	4999	1343		
Dredging less at Ravenswood than at Portland (Dillman)	5000	1343		
Drum Forebay comparable with Herrmann's estimates on Pilarcitos			5133	1382
Drum Forebay near Lake Spaulding (Herrmann)			4969	1333
Drum Forebay overhead not included (Herrmann)			5133	1382
Dry Canyon Dam, Los Angeles Aqueduct (Herrmann)			4971	1334
Earth Dams, detail estimates (Dillman)	5013	1347		
Earth Dams, Los Angeles, Dockweiler has detail of	5033	1353		
Eastern pipe can be manufactured from 10 to 12% cheaper than here (Dorward)	4922	1317		
Embankment Drum Forebay (Herrmann)			5130	1381
Embankment Drum Forebay comparable to Pilarcitos (Herrmann)			5130	1381

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
COST—Continued.				
Embankment estimate for Pilarcitos earth dam (Hazen)			4948	1324
Embankment estimate for San Andres Dam (Hazen)			4948	1324
Embankment Modesto District Dam (Herrmann)			5142	1385
Embankments, Twin Lakes (Ellis)	5354	1419		
Embankments, unit costs (Dillman)	5013	1347		
Embankments, Wild Horse Dam No. 2 (Vallejo, Cal.) (Noyes)	5268	1424		
Equipment, depreciation not a field cost (Herrmann)			5150	1388
Equipment for handling sand at Crystal Springs Dam (Hazen)			5415	1462
Estimated cost of barge and tugboat service for laying submerged pipe (Dockweiler)	4781	1279		
Estimated cost of embankment for Pilarcitos and San Andres Dams (Ellis)	5231	1412		
Estimates of Dockweiler and Dillman on San Andres pipe line, compared with Hazen cost			4380	1169
Excavation, Alameda pipe line 1888			4390	1171
Excavation, Argonaut pipe line (Ellis)	4886	1308		
Excavation, assumed at 50c a cubic yard for ordinary (Dillman)	4417	1181		
Excavation, average cost estimated including backfill and excluding paving re-placement (Ellis)	4886	1308		
Excavation, Bull Run line, Portland (Dockweiler)	4452	1192		
Excavation, Bull Run pipe line, Portland (Hazen)			4509	1206
Excavation, correction in testimony Hazen cost of excavation Portland, Or., 1894			4393	1172
Excavation, costs at Portland, Ore. (Hazen)			4506	1205
Excavation, Crocker Tract (Ellis)	4887	1308		
Excavation, Crystal Springs Dam (Hazen)			5408	1459
Excavation elimination of State Highway makes Ellis' figures 65c instead of 70c (Ellis)	4888	1309		
Excavation estimate based on hand work (Ellis)	4888	1308		
Excavation estimated cost flumes (Hazen)			5221	1408
(Hazen)			5215	1406
Excavation 54" Alameda pipe line (Hazen)			4391	1171
Excavation for Contra Costa pipe line from glue factory to San Leandro (Dillman)	4418	1181		
Excavation for flumes (Herrmann)			5373	1449
(Lawrence)			5377	1450
(Hazen)			5455	1476
Excavation for flumes, Hazen's own estimates			5216	1406
Excavation for flumes, method of estimating cost.			5214	1406
Excavation for 40" line laid in Los Angeles (Dockweiler)	4459–4461	1192		

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COST—Continued.				
Excavation, grubbing not included in cost on Bull Run pipe line, Portland, Ore. (Hazen)			4507–4508	1206
Excavation, Hazen's estimate of 75c per yard was based on his experience			4563	1221
Excavation, Los Angeles, for 40" line (Dockweiler)	4459–4461	1192		
Excavation of distribution system including backfill 75c per cubic yard (Hazen)			4356	1161
Excavation on 36" 5/16" steel line in Los Angeles (Dockweiler)	4462	1193		
Excavation, Portland, Ore. (1894) (Hazen)			4392	1172
(1911) (Hazen)			4392	1172
Excavation riveted pipe lines (Hazen)			4388	1170
Excavation riveted pipe line, method of arriving at (Hazen)			4389–4390	1170–1171
Excavation Seattle, Portland and Victoria, used records (Hazen)			4564	1222
Excavation shaft at Elizabeth tunnel (Lippincott)			5534	1500
Excavation Spring Valley system 70c a cubic yard (Ellis)	4886	1308		
Excavation Stanislaus work cheaper than Spring Valley (Dillman)	4687	1255		
Excavation trenches, wide trench costs more than a narrow one (Ellis)	4995	1341		
Excavation unit prices of Ellis compared to Hazen's	4998	1342		
Excavation Wild Horse Dam No. 2 (Vallejo, Cal.) (Noyes)	5269	1424		
Excavation would be about same as in East (Hazen)			4563	1221
Exploration not included in estimate on Pilarcitos Dam (Herrmann)			5117	1378
Exploration not included in unit costs for earth dams (Herrmann)			4993	
Fabricating and laying original Spring Valley pipe by Risdon Iron Works, table by Dorward	4891–4899	1304–1311		
Fabrication and wages, in making steel pipe, have not dropped since beginning of European war (Dockweiler)	4675	1252		
Fabrication, basis of assumption that wrought iron would cost less than steel (Dillman)	4699	1259		
Fabrication, cost of would be greater in San Francisco than in East (Hazen)			4493	1201
Fabrication from F. Hewson on 24" pipe (Dockweiler)	4630	1241		
Fabrication, from Monterey Water Works (Dockweiler)	4630	1241		
Fabrication, from various people (Dockweiler)	4630	1241		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
COST—Continued.				
Fabrication, Hazen's estimate based on what it cost Spring Valley to make pipe without connections			4539	1214
Fabrication, of Pine Canyon line could not be segregated for different thickness of steel (Hazen)			4553	1218
Fabrication, of riveted pipe higher in Los Angeles than in the East (Hazen)			4516	1208
Fabrication, of steel more than iron (Dillman)	4431	1184		
Fabrication, on riveted pipe (Moebus)	4935	1320		
Fabrication, per lb. for shopwork and work in trench for straight pipe only (Hazen)			4538	1213
Fabrication, reason for adding 9.4% to Eastern to obtain Spring Valley cost (Hazen)			4533	1213
Fabrication, riveted pipe, quotations not to be depended on (Hazen)			4569	1224
Fabrication, syphons for Los Angeles Aqueduct (Hazen)			4551	1217
Figures given by Lawrence represent actual minimum expenditure			4407	1177
Figures given by Lawrence represent actual expenditures made by company			4407	1177
Fill, Calaveras Dam (Hazen)			5110	1375
Fill, hydraulic, Modesto Irrigation District			4972	1334
Flumes, detail of (Herrmann)			5368	1447
Flumes, Hazen used Lawrence's figures in his estimate			5213	1405
Flumes, items included in estimates (Herrmann)			5367	1447
Flumes, Los Gatos Canyon (Herrmann)			5365	1446
Flumes, method of figuring (Hazen)			5213	1405
Flumes, Modesto Irrigation District (Herrmann)			5362	1445
Flumes, South San Joaquin Irrigation District (Herrmann)			5363	1446
Frames, a part of concrete cost (Dillman)	5168	1393		
Francis Smith Co. of making Spring Valley 36" pipe (Moebus)	4934	1320		
Franklin Canyon Dam, Hazen did not have cost of, at time of appraisal			5108	1375
Fresno scrapers with drivers, Alamo Dam, Imperial Valley (Herrmann)			5140	1384
Galvanizing submerged pipe (Hazen)			4865	1302
Haiwee Dam, North Los Angeles Aqueduct			4971	1334
Haiwee Dam, South Los Angeles Aqueduct (Herrmann)			4971	1334
Hauling, Antelope Syphon Plant (Dockweiler)	4557	1219		
Hauling concrete, total cost per cubic yard Crystal Springs Dam (Hazen)			5419	1463

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
COST—Continued.				
Hauling, Crystal Springs Dam (Lippincott)			5468	1480
Hauling, earth dams, unit costs by Dockweiler	5047	1357		
Hauling, estimated on basis of $5 per ton (Hazen)			4490	1200
Hauling, for flumes at Calaveras (Herrmann)			5368	1447
Hauling, for flumes at San Andres (Herrmann)			5369	1448
Hauling, for flumes, cost per ton mile (Herrmann)			5369	1448
Hauling, increase in cost of due to labor and teams (Hazen)			4490	1200
Hauling, Los Angeles Aqueduct (Lippincott)			5468	1480
Hauling, material from steam shovel at Calaveras (Herrmann)			4966–4967	1332
Hauling, of material for Crystal Springs Dam (Hazen)			5413	1461
Hauling sand, Crystal Springs Dam (Hazen)			5416	1462
Healy & Tibbitts table showing detailed cost of laying submerged pipe (Dockweiler)	4782–4783	1279–1280		
Hewson furnished fabrication on 24" pipe (Dockweiler)	4630	1241		
Inspection might add to cost wrought iron (Dillman)	4694	1257		
Inspectors usually leave out important items in keeping shop costs (Hazen)			4762	1273
Intake pipe work not applicable to this work (Hazen)			4831	1293
Intake work in some cases cost of are comparable to Spring Valley costs (Metcalf)			4846	1298
Iron, charcoal, for Alameda 54" pipe line 5½c per lb. (Hazen)			4354	1160
Iron puddled of extra quality for riveted pipe in Spring Valley system 4c per lb. (Hazen)			4353	1160
Iron, wrought, Dillman's estimate based on reproduction cost of	4415	1179		
Iron, wrought, quotations from Allan Wood added 25% to cost of steel (Dillman)	4695	1258		
Labor advanced 80% between 1898 and 1914 (Lawrence)			4401	1175
Labor, Albany, N. Y.			5444	1472
Labor, assumed at Crystal Springs Dam (Hazen)			5428	1467
Labor, average on Eastern dams (Hazen)			5427	1467
Labor, California compared with Eastern conditions (Hazen)			4568	1223
Labor, comparisons on earth dams, east and west (Hazen)			5087	1368
Labor cost, etc., Borden Brook Dam (Springfield, Mass.) (Hazen)			5087	1368
Labor costs kept separately (Lawrence)			4400	
Labor costs of excavation for riveted pipe (Lawrence)			5332	1438

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
COST—Continued.				
Labor, Crystal Springs Dam (Hazen)			5443	1472
Labor, dipping riveted pipe (Lawrence)			5323–5324	1436
Labor, Ellis familiar with in San Francisco bay section	4886	1308		
Labor, 54" Alameda line, Lawrence analysis			4401	1175
Labor for steel pipe, Monterey Water Co. (Rhodes)	4750	1270		
Labor, Hazen's assumed cost, etc., on Pilarcitos Dam			5089	1369
Labor, Hazen obtained information from Southern Pacific Payroll, concerning			4568	1223
Labor here would be 20% greater than in the East (Dorward)	4922	1317		
Labor, increase between 1913 and 1915 on Eastern dams (Hazen)			5427	1467
Labor, laying submerged pipe (Dockweiler)	4874	1304		
Labor, Little River, Mass. (Hazen)			5445	1473
Labor, material Crystal Springs Dam compared with Eastern work (Hazen)			5447	1474
Labor, not more efficient on Pacific Coast than in the East (Hazen)			4575	1225
Labor, Ogdensburg, N. Y. (Hazen)			5446	1474
Labor, on Colorado River levees (Herrmann)			4963	1331
Labor, on concrete Crystal Springs Dam (Hazen)			5418	1463
Labor, on Drum Forebay (Herrmann)			5130	1381
Labor, on riveted pipe, Hazen made inquiries in San Francisco concerning labor conditions			4568	1223
			4574	1225
Labor, on submerged pipe would be greater at present date (Hazen)			4770	1276
Labor, Peekskill, N. Y. (Hazen)			5445	1473
Labor, Pilarcitos Dam (Herrmann)			5144	1385
Labor, pipe fabrication (Dockweiler)	4634	1242		
	4648	1247		
Labor, Southern Pacific, in neighborhood of San Francisco (Hazen)			5098	1371
Labor, Toronto, Canada			5446	1473
Labor, trenching earth dams (Dockweiler)	5050	1358		
Labor, union rate in San Mateo County $2.50 a day (Lawrence)			4408	1177
Labor, visited Risdon Iron Works for information (Dockweiler)	4634	1242		
Labor, Washington, D. C. (Hazen)			5445	1473
Labor, Wild Horse Dam No. 2 10 hours (Noyes)	5271	1425		
Labor, Yonkers, N. Y. (Hazen)			5446	1473
Lagging at Pilarcitos and San Andres (Dillman)	5156	1389		
Lake Arthur Dam built by Pacific Gas & Electric Co. (Herrmann)			4970	1333

COST—Continued.	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
Lake Valley Dam, built by Pacific Gas & Electric Co. (Herrmann)			4970	1333
Lawrence, analysis of riveted pipe			4395–4406	1173–1177
Laying, analysis of (Dockweiler)	4659	1249		
Laying and joining 36", 37" and 44" pipe (Dockweiler	4650	1247		
Laying, comparison of Dockweiler's costs and costs in Schaw-Batcher Co.'s letter for 44" pipe	4663	1249		
Laying, Dillman made no segregation for	4854	1300		
Laying riveted pipe, Schaw-Batcher letter quoting prices (Dockweiler)	4653	1248		
Laying was not part of Risdon shop account of Spring Valley riveted pipe (Dorward)	4911	1314		
Los Angeles Aqueduct, Antelope syphon (Hazen)			4550	1217
Los Angeles Aqueduct, auxiliary expense (Hazen)			4559	1220
Los Angeles Aqueduct, dams (Herrmann)			4971	1333
Los Angeles Aqueduct, Dockweiler familiar with	5029	1352		
Los Angeles Aqueduct, indirect costs of pipe were very great (Hazen)			4558	1219
Los Angeles Aqueduct, method of keeping (Lippincott)			5488	1487
Los Angeles Aqueduct, not to be taken as basis in this case (Metcalf)			4583	1229
Los Angeles, Dockweiler obtained records of riveted pipe from Mulholland	4671	1251		
Los Angeles earth dams, Dockweiler has detail cost of	5033	1353		
Los Angeles records, copies by J. G. White Co. (Dockweiler)	4585	1229		
Lumber at San Mateo (Lippincott)			5478	1484
Lumber for flumes (Dockweiler)	5366	1447		
Lumber for flumes f.o.b. Millbrae (Herrmann)			5365	1446
Manufacture of all pipes of Spring Valley (Hazen)			4344	1156
Manufacture of pipe much higher at present than when Spring Valley pipe was made (Hazen)			4346	1156
Manufacture of slip joint pipe reduced 1c per lb. under riveted pipe (Hazen)			4353	1160
Manufacturing steel pipe, method (Hazen)			4335–4336	1152–1153
Manufacturing wrought iron pipe, method (Hazen)			4336	1153
Masonry, Kensico Dam, (N. Y.) (Hazen)			5421	1464
Material, Albany, N. Y. (Hazen)			5444	1472
Material, dull times make a difference in prices (Hazen)			4815	1289
Material, Little River, Mass. (Hazen)			5445	1473
Material, Ogdensburg, N. Y. (Hazen)			5446	1474
Material, Peekskill, N. Y. (Hazen)			5445	1473
Material, Toronto, Can. (Hazen)			5446	1473
Material, Washington, D. C. (Hazen)			5444	1473

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
COST—Continued.				
Material, Yonkers, N. Y. (Hazen)			5446	1473
Materials, unit cost for in earth dams (Hazen)			4951	1325
Metal in San Andres pipe line (Hazen)			4341	1155
Millbrae force main, Lawrence analysis			4403	1176
Moebus did not preserve any cost data on Spring Valley work	4931	1319		
Monterey Water Co., Dockweiler knew of	4736			
Monterey Water Co., power per month used in making steel pipe (Rhodes)	4742	1268		
Monterey Water Co., Rhodes did not check with Montague shop cost on steel pipe	4752	1271		
Monterey Water Co., Rhodes does not know what paid for steel pipe	4750	1270		
Monterey Water Co., Rhodes kept analysis of shop costs on steel pipe	4739	1267		
New Era Graders (Noyes)	5279	1426		
New Era Graders, operating, etc. (Dillman)	5292	1429		
New River flume, Imperial Valley (Herrmann)			5365	1446
No attention paid to original cost of Pilarcitos and San Andres Dams in 1913 estimate (Hazen)			5111	1375
One day at Risdon Iron Works was only information Dockweiler has as to cost	4640	1244		
Overhead, Dillman's table on San Andres line does not include	4380	1169		
Overhead, Risdon added 50% (Dorward)	4893	1310		
Park pipe line .087c per lb. (Dockweiler)	4524	1210		
Park line not comparable (Hazen)			4366	1164
			4394	1173
Pavements, cutting and replacing, part of reproduction (Dockweiler)	4868	1303		
Pavements, cutting and replacing, Spring Valley systems (Hazen)			4372	1167
Pilarcitos and San Andres Dams, unit costs the same (Herrmann)			4963	1330
Pilarcitos Dam, detail unit costs (Ellis)	5232	1412		
Pilarcitos Dam, difference between unit costs, Dockweiler and Hazen	5066–5068	1363		
Pilarcitos Dam, estimate (Herrmann)			4973	1334
Pilarcitos Dam, total estimated cost of (Hazen)			4949	1324
Pilarcitos Dam, unit cost of puddling (Hazen)			4956	1328
Pilarcitos Dam, unit cost on various methods of work (Herrmann)			4976–4977	1335–1336
Pipe, average for certain lines, undipped 4c per lb. (Lawrence)			4397	1174
Pipe, average of Spring Valley straight (Hazen)			4340–4341	1154–1155
Pipe, average unit cost (Hazen)			4491–4492	1200–1201
Pipe, cheaper in Los Angeles than in San Francisco at present time (Hazen)			4348	1157

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
COST—Continued.				
Pipe, Connecticut River (Hazen)			4828	1292
Pipe, East Jersey Pipe Co. can sell pipe cheaper than other companies (Hazen)			4549	1217
Pipe riveted, actual costs not obtained from books of Risdon Iron Works (Dorward)	4892–4897	1310–1311		
Pipe riveted, basis of cost used by Hazen			4492	1201
Pipe riveted, basis of fabrication cost (Hazen)			4492	1201
Pipe riveted, cleaning (Dockweiler)	4640	1244		
Pipe riveted, detail of Risdon Iron Works shop work on (Dorward)	4907	1313		
Pipe riveted, Dorward's costs on, are without the profits on contract	4901	1311		
Pipe riveted, Dorward doesn't know cost of transportation	4902	1311		
Pipe riveted, Dorward does not include bends	4928	1319		
Pipe Riveted, Dorward's estimate as of Dec. 31, 1913	4917	1315		
Pipe riveted, Dorward's estimate higher than Hazen's	4929	1319		
Pipe riveted, Dorward's method of figuring	4894	1310		
Pipe riveted, excavation, unit prices of Ellis and Hazen compared	4998	1342		
Pipe riveted, fabrication (Moebus)	4935	1320		
Pipe riveted, 5/16" x 36" at Akron, O. (Hazen)			4512	1207
Pipe riveted, information from Francis Smith (Dockweiler)	4631	1241		
Pipe riveted, information from which cost was figured (Dorward)	4891	1309		
Pipe riveted, Lawrence analysis sheet "P 4"			4397	1174
Pipe riveted, Lawrence analysis shows cost of handling, sheet "P 8"			4400	1175
Pipe riveted, Lawrence analysis shows freight on, sheet "P 9"			4400	1175
Pipe riveted, laying not a part of Risdon shop account (Dorward)	4911	1314		
Pipe riveted, laying Schaw-Batcher letter quoting prices (Dockweiler)	4653	1248		
Pipe riveted, Los Angeles, Dockweiler obtained records from Mulholland	4671	1251		
Pipe riveted, manufacture and cost of laying, figured separately from plates (Hazen)			4334	1152
Pipe riveted, method of estimating (Dockweiler)	4432	1184		
Pipe riveted, method of obtaining total (Hazen)			4388	1170
Pipe riveted, Minneapolis 48" and 54" (Hazen)			4510	1207
Pipe riveted, not much increase in cost of making between 1907-1912	4934	1320		
Pipe riveted, obtained from Spring Valley records (Hazen)			4535	1213

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
COST—Continued.				
Pipe riveted, Park Line (Dockweiler)	4524	1210		
Pipe riveted, per lb. finished without accessories (Hazen)			4352	1159
Pipe riveted, Risdon's estimated as of December 31, 1913 (Dorward)	4920	1316		
Pipe riveted, summary showing cost of line at Portland, Ore., and percentage for accessories (Hazen)			4363–4364	1163–1164
Pipe riveted, 32" line at Springfield, Mass. (Hazen)			4362	1163
Pipe riveted, total cost per foot in trench (Hazen)			4490	1200
Pipe riveted, total for whole Spring Valley system without accessories (Hazen)			4355	1161
Pipe riveted, total manufacturing 1915 (Hazen)			4387	1170
Pipe riveted, total reproduction of Spring Valley Water Co. laid complete (Hazen)			4372	1167
Pipe riveted, wrought iron in Alameda line (Hazen)			4341	1155
Pipe riveted, wrought iron shown on sheet "P 25" Lawrence's analysis			4405	1176
Pipe, Sacramento (Dockweiler)	4814	1288		
Pipe, steel, Baker Iron Works per lb. Los Angeles (Dockweiler)	4639	1243		
Pipe, steel, Rhodes did not check with Montague shop cost	4752	1271		
Pipe, steel, Rhodes does not know what Monterey Water Co. paid	4750	1270		
Pipe work, Oakdale Irrigation District (Dillman)	4730	1266		
Pipe, wrought iron, Dillman explains how he made and applied his table	4417	1181		
Pipe, wrought iron, Dillman's table showing cost of	4416	1180		
Plates wrought iron, cost 70% more than steel f.o.b. San Francisco (Hazen)			4802–4803	1285
Pleasanton Line, allowed less for best Spring Valley pipe, than this line (Dockweiler)	4607	1235		
Pleasanton Line, estimated at $2.82 per lineal foot (Dockweiler)	4604	1234		
Pleasanton-Sunol pipe line shown on sheet "P 27", Lawrence analysis			4405	1176
Power per month making steel pipe for Monterey Water Co. (Rhodes)	4742	1268		
Power plant at Calaveras (Herrmann)			5123	1379
Price of steel dropped because of Panama Canal opening (Dillman)	4676			
Puddle excavation South Haiwee Dam, Los Angeles (Herrmann)			5116	1377
Puddle fill Dry Canyon Dam (Dockweiler)	5199	1402		
Puddling at Taubeaud Dam (Ellis)	5245	1416		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
COST—Continued.				
Puddling, Crystal Springs Dam, detail cost (Lippincott)			5486	1486
Puddling, difference between Pilarcitos and San Andres Dams (Dockweiler)	5070	1364		
Puddling, Dry Canyon Dam, Los Angeles Aqueduct (Dockweiler)	5062	1362		
Puddling earth dams, unit cost of (Dockweiler)	5071	1365		
Puddling earth dams, unit cost (Hazen)			4953	1326
Puddling, estimated costs on Crystal Springs Dam (Lippincott)			5486	1486
Puddling, unit cost, San Andres (Hazen)			4953	1326
Puddling, unit cost of (Dillman)	5024–5028	1350–1351		
Ravenswood, Dillman's estimate on line	4849–4850	1299		
Rhodes don't know anything of Schaw-Batcher shop cost on P. P. I. E. pipe	4755	2171		
Rhodes kept analysis of shop costs on Monterey Water Co. steel pipe	4739	1267		
Rip rap, loose, unit cost (Herrmann)			4987	1340
Rip rap, Pilarcitos Dam, Dockweiler's cost of quarrying	5058	1361		
Rip rap, Pilarcitos Dam, for hauling and placing (Dockweiler)	5058	1361		
Rip rap, unit cost (Dillman)	5025	1350		
Rip rap, unit cost (Herrmann)			4987	1340
Rip rap, Wild Horse Dam No. 2 (Vallejo, Cal.) (Noyes)	5273	1425		
Risdon added 50% to cost, for overhead (Dorward)	4893	1310		
Risdon's estimated cost on Spring Valley riveted pipe as of December, 1913 (Dorward)	4920	1316		
Riveted pipe, explanation of original cost table (Lawrence)			4396	1174
Riveted pipe, f.o.b. Ottawa, Canada (Hazen)			4495	1202
Riveted pipe, lines in Brooklyn, N. Y. (Hazen)			4364–4365	1164
Riveted pipe, made in East and shipped to San Francisco would result in economy (Hazen)			4347	1157
Riveted pipe, original cost could be worked up from Spring Valley Water Co.'s records (Lawrence)			5326	1436
Riveted pipe, principal difference between wrought iron and steel in cost of metal (Hazen)			4802	
Riveted pipe, through Golden Gate Park (Hazen)			4393	1172
Riveted pipe, see also Pipe riveted.				
Riveting, Dillman does not care to go into detail	4431	1184		
Riveting, if properly done, is quite an item in cost (Hazen)			4803	1285
Riveting, shop cost, detail of (Dockweiler)	4627	1240		

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
COST—Continued.				
Riveting and caulking ¼" plate in trench, Portland, Ore. (Hazen)			4495	1202
Rivets, average cost (Lawrence)			4397	1174
Road and trails at Calaveras cost more than on the Los Angeles Aqueduct (Herrmann)			5117	1378
Road work in riveted pipe items, charged for (Lawrence)			5331	1437
Rock, Crystal Springs Dam (Hazen)			5417	1462
Rock, estimated cost at Crystal Springs Dam (Lippincott)			5527	1467
Rock, Crystal Springs Dam, detailed cost of (Lippincott)			5477	1483
San Andres Dam, detailed unit costs (Ellis)	5232	1412		
San Andres Dam, difference between unit costs, Dockweiler and Hazen	5066–5068	1363		
San Andres Dam, estimate (Herrmann)			4973	1334
San Andres Dam, estimated unit cost (Hazen)			4950	1325
San Andres Dam, total estimated cost of (Hazen)			4950	1325
San Andres Dam, unit costs, compared to those of Pilarcitos (Dockweiler)	5066	1363		
San Andres Dam, unit costs of various methods of work (Herrmann)			4976–4977	1335–1337
San Andres Line (Baden Merced Branch) Lawrence analysis			4406	1177
San Andres Line, difference of $101,000 between Dockweiler and Hazen			4438	1186
San Andres Line, Dillman's total cost including overhead	4380	1169		
San Andres Line, Dockweiler's total not including overhead	4380	1169		
San Andres Line, extras amount to $2795 (Dillman)	4420	1182		
San Andres Line, 44" x ¼" and estimate			4567	1223
San Andres Line, 44" x ¼" cheapest work Spring Valley ever did (Hazen)			4567	1223
San Andres Line, 44" pipe, Lawrence analysis			4400	1175
San Andres Line per foot (Hazen)			4378	1169
San Andres Line, total $278,653 or $9.20 per foot (Dillman)	4420	1182		
San Andres 44" line, total for excavation (Dockweiler)	4437	1186		
Sand at Crystal Springs Dam (Hazen)			5415–5420	1462–1464
Sand at San Mateo, estimated cost of (Lippincott)			5525	1466
Sand for Crystal Springs Dam as per letter Spring Valley purchasing agent (Lippincott)			5475	1483
Sand, total cost per cubic yard Crystal Springs Dam (Hazen)			5416	1462

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
COST—Continued.				
San Mateo Creek Dam No. 1, estimated cost (Dillman)	5028	1351		
San Mateo Creek Dam No. 1, unit costs (Dockweiler)	5078	1366		
San Mateo Creek Dams unit costs same as Pilarcitos and San Andres (Hazen)			4956	1328
Shop costs about same in 1900 as in 1912 (Moebus)	4936	1320		
Shop costs how obtained (Hazen)			4763	1273
Stanislaus work excavation, cheaper than on Spring Valley (Dillman)	4687	1255		
Steam shovel, daily operating (Dockweiler)	5043	1356		
Steam shovel, details operating (Dockweiler)	5047	1357		
Steam shovel, material placed by at Calaveras (Herrmann)			5143	1385
Steam shovel, method of figuring (Dockweiler)	5043	1356		
Steam shovel, moving at Calaveras (Herrmann)			4989	1340
Steam shovel, operating (Dillman)	5292	1429		
Steam shovel, operating (Dockweiler)	5211	1404		
Steam shovel, operating at Calaveras (Herrmann)			4979	1337
Steam shovel, operations, estimate on basis of operating 300 days a year (Dockweiler)	5044	1356		
Steam shovel, per mile to ship (Dillman)	5130			
Steam shovel, to ship into Pilarcitos (Dockweiler)	5130			
Steam shovel, 6.3c. per cubic yard for handling material (Dockweiler)	5045	1357		
Steam shovel work, Calaveras Dam (Herrmann)			4970	1333
Steam shovel work, Calaveras Dam (Elliott)			5384	1453
Steam shovel work, present cost of, at Calaveras Dam (Hazen)			5110	1375
Steel for riveted pipe in Spring Valley system 2¼c. per lb. f. o. b. San Francisco (Hazen)			4354	1160
Steel, price of, dropped because of Panama Canal opening (Dillman)	4676			
Stock, estimated cost of (Ellis)	5254	1419		
Stock, rental cost of, at Calaveras (Herrmann)			5140	1384
Stone Dam 44" line, Lawrence's analysis			4402	1176
Stripping, at Calaveras (Herrmann)			4966	1331
			5122–5123	1379
Stripping, at Government Dam (Lippincott)			5484	1485
Stripping at Pilarcitos (Herrmann)			5122–5123	1379
Stripping, Calaveras borrow pits (Herrmann)			5122	1379
Stripping, Crystal Springs Dam, estimated cost (Lippincott)			5484	1485
			5531	1500
Stripping, estimated cost for Pilarcitos (Hazen)			4949	1324

COST—Continued.	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
Stripping, estimated Pilarcitos and San Andres Dams (Ellis)	5232	1412		
Stripping, Gibraltar Dam (Lippincott)			5484	1485
			5532	1500
Stripping, method of estimatng cost of, Pilarcitos Dam (Herrmann)			5124–5125	1379–1380
Stripping, Roosevelt Dam (Lippincott)			5484	1485
Stripping, unit cost and method of computing (Dockweiler)	5031	1352		
Stripping, unit costs of Pilarcitos Reservoir (Herrmann)			4965–4966	1331
Structures, auxiliary for concrete, Crystal Springs Dam (Hazen)			5417	1462
Structures, special along certain riveted pipe lines of Spring Valley (Hazen)			4372–4373	1167
Submerged pipe, actual cost to Spring Valley Co. $9.50; Dockweiler's estimate $3.95 for 16" pipe	4864	1302		
Submerged pipe, barge and tug boat service (Dockweiler)	4791	1282		
Submerged pipe, cast iron, laying (Metcalf)			4842	1296
Submerged pipe, Connecticut River line was $39.90 a foot (Hazen)			4828	
Submerged pipe, contingencies were added to cover Dockweiler's lack of knowledge on details	4878	1305		
Submerged pipes, contingencies were based on Dockweiler's judgment	4879	1305		
Submerged pipe, contract for laying Spring Valley 22" (Hazen)			4767	1274
Submerged pipe, cost of laying 24" line at Portland, Ore. (Hazen)			4768	1275
Submerged pipe, cost of laying 28" line at Portland, Ore. (Hazen)			4768	1275
Submerged pipe, cost of laying 30" line at Portland, Ore. (Hazen)			4769	1275
Submerged pipe, cost of laying 30" line at Springfield, Mass. (Hazen)			4768	1275
Submerged pipe, detail of cost of 22" line of Spring Valley (Hazen)			4770	1276
Submerged pipe, detail of laying 16" (Dockweiler)	4776	1278		
Submerged pipe, detail cost of laying (Dockweiler)	4784	1281		
Submerged pipe, detailed unit costs on (Dockweiler)	4773–4774	1277–1278		
	4775	1278		
Submerged pipe, Dillman's formula would not apply to light pipes	4853	1300		

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	Record	Abstract	Record	Abstract
COST—Continued.				
Submerged pipe, Dockweiler's cost for lead per pound	4780	1279		
Submerged pipe, detailed estimate for laying 22"	4791	1282		
Submerged pipe, detail, unit of cost on 22"	4791	1282		
Submerged pipe, Dockweiler's estimate on laying of	4875	1304		
Submerged pipe, estimates compared to actual cost for 16" (Dockweiler)	4866	1303		
Submerged pipe, Dumbarton being a longer crossing, would make average cost less (Dillman)	5008	1346		
Submerged pipe, figures referring to intake work not available as index to cost of (Metcalf)			4846	1298
Submerged pipe, for dredging at Portland (Dillman)	4999	1343		
Submerged pipe, galvanizing, Dockweiler's cost not segregated	4865	1302		
Submerged pipe, Hazen considered cost in estimating			4760	1272
Submerged pipe, Hazen considered the Spring Valley cost very low			4831	1293
Submerged pipe, Hazen's cost of lead per lb.			4780	1279
Submerged pipe, Healy & Tibbits table of detailed cost of laying (Dockweiler)	4782–4783	1279–1280		
Submerged pipe, labor in laying (Dockweiler)	4874	1304		
Submerged pipe, laid by Metcalf			4841–4848	1296–1298
Submerged pipe, material for Vancouver line (Hazen)			4838	1295
Submerged pipe, material would be about the same price today (Hazen)			4770	1276
Submerged pipe, New Bedford (Metcalf)			4847	1298
Submerged pipe, Portland, Ore. (Hazen)			5004	1345
Submerged pipe, Portland, Ore., method of computing (Dillman)	5000	1343		
Submerged pipe, Portland, Ore., unit (Dillman)	4998	1342		
Submerged pipe, reasons why the pipe should cost less after the 16" was laid (Dockweiler)	4867	1303		
Submerged pipe, total cost of laying (Dockweiler)	4784	1281		
Submerged pipe, total cost for laying (Hazen)			4784	1281
Submerged pipe, total on 22" (Dockweiler)	4791	1282		
Submerged pipe, 22" (Hazen)			4770	1276
Submerged pipe, Vancouver (Hazen)			4769	1275
Submerged pipe, would not have affected Dockweiler's estimate, had he known an experienced crew had laid pipe	4872	1304		
Submerged pipe, winds would cause extra expense at Dumbarton (Dillman)	5010	1346		

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	Record	Abstract	Record	Abstract
COST—Continued.				
Submerged pipe, work Dockweiler did not get figures, other than Spring Valley	4880	1306		
Summary pipe riveted, of main lines 1914-1915 (Hazen)			4388	1170
Sunol Filter Galleries, units of (Hazen)			5457	1477
Syphons, Los Angeles Aqueduct, notes on (Hazen)			4549	1217
Syphons, ¼" Los Angeles Aqueduct (Hazen)			4502	1204
Tabeaud Dam, complete, not known by Ellis	5245	1416		
Tabeaud Dam, puddling (Ellis)	5245	1416		
Tabeaud Dam, wages paid (Ellis)	5233	1413		
Teams at Calaveras (Herrmann)			5315	1434
Teams, detail cost of (Dockweiler)	5205	1403		
Teams, estimated, Pilarcitos (Ellis)	5254	1419		
The 20% additional for wrought iron pipe as compared to steel is for fabricated pipe (Dockweiler)	4804	1286		
30 to 35% should be added to Risdon Iron Works' figures for 1913 reproduction cost (Dorward)	4921	1316		
Timbering at San Andres and Pilarcitos Dams (Dillman)	5156	1389		
Timbering earth dams, details of cost (Dockweiler)	5050	1358		
Transportation of pipe on Alameda pipe line from shop to ditch (Hazen)			4343	1155
Transportation of pipe San Andres pipe line from shop to ditch			4343	1155
Transportation steam shovel			4977	1336
Transportation steam shovel into Calaveras (Herrmann)			4978	1336
Trench excavation (Ellis)	4995	1341		
Trenching at Dry Canyon Dam, Los Angeles Aqueduct (Herrmann)			4981	1337
Trenching Calaveras Dam (Herrmann)			4983	1338
			5155	1389
Trenching, difference in cost between San Andres and Pilarcitos Dams (Dockweiler)	5068	1363		
Trenching earth dams (Dillman)	5021	1349		
Trenching earth dams (Dockweiler)	5053	1359		
Trenching earth dams, details of (Dockweiler)	5049	1358		
Trenching, Hazen used machine in his estimates			4815	1289
Trenching Los Angeles Aqueduct (Herrmann)			5155	1389
Trenching machine a saving over hand labor (Dockweiler)	4814	1288		
Trenching Modesto Irrigation District (Herrmann)			4982	1338
			5155	1389
Trenching North Haiwee Dam, Los Angeles Aqueduct (Herrmann)			4982	1338

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	Record	Abstract	Record	Abstract
COST—Continued.				
Trenching South Haiwee Dam, Los Angeles Aqueduct (Herrmann)			4982	1338
Trenching on San Andres (Dillman)	5027	1351		
Trenching on Springfield system (Hazen)			5102	1373
Trenching riveted pipe, unit price for in State Highway (Ellis)	4997	1342		
Trenching, unit cost of, on Pilarcitos Dam (Hazen)			4951	1325
Truck operating (Herrmann)			5368	1447
Tunnels, Crystal Springs Dam, reasons for high cost (Lippincott)			5485	1485
Twin Lakes embankments (Ellis)	5254	1419		
Wenzelburger's report of Crystal Springs Dam adjusted to Hazen's report			5434	1469
Wenzelburger's report, Crystal Springs Dam, segregation of			5434	1469
Wild Horse Dam No. 2, embankment	5268	1424		
Wild Horse Dam No. 2, excavation (Noyes)	5269	1424		
Wild Horse Dam No. 2, labor (Noyes)	5271	1425		
Wild Horse Dam No. 2, total (Noyes)	5267	1423		
CROCKER TRACT				
Cost of excavation 15½c. cubic yard, backfill 3.2c. (Ellis)	4887	1308		
CROSS RIVER DAM (N. Y.)				
Description of (Hazen)			5423	1465
CROTON DAM, N. Y.				
Compared with Crystal Springs Upper Dam (Hazen)			5107	1374
CRYSTAL SPRINGS DAM (LOWER)				
Appraisal, Lippincott made a valuation as of December 31, 1913			5467	1480
Appraisal points considered (Hazen)			5412	1460
Blocks method of building (Hazen)			5439	1471
Brickwork, cement required (Lippincott)			5534	1500
Brickwork, estimated unit cost of (Hazen)			5448	1474
Brickwork, quantities and unit costs of (Hazen)			5409	1459
Cement, cost of (Hazen)			5414–5428	1461–1467
Cement, cost of at Colton (Lippincott)			5517B	1496
Cement, cost of at Los Angeles (Lippincott)			5471–5473	1481–1482
Cement, cost of at Mojave (Lippincott)			5517B	1496
Cement, cost of at Santa Barbara (Lippincott)			5470	1481
Cement, cost of at Spaulding (Lippincott)			5520	1497
Cement, cost of blending Tufa cement, Los Angeles Aqueduct (Lippincott)			5517A	1496
Cement, cost of manufacture (Lippincott)			5471	1496
Cement, cost of manufacture would be more near San Francisco than in East (Hazen)			5428	1467

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	Record	Abstract	Record	Abstract
CRYSTAL SPRINGS DAM (LOWER)—Continued.				
Cement, cost of manufacture in San Francisco 68c per barrel (Dockweiler)	5428	1467		
Cement, cost of manufacture, Oro Grande 68c. per barrel (Dockweiler)	5429	1468		
Cement, cost of manufacture at Oro Grande does not include selling cost (Dockweiler)	5430	1468		
Cement, estimated cost at San Mateo (Lippincott)			5471–5474	1481–1482
Cement, percentage of bags that could be returned (Hazen)			5414	1461
Cement, price of at San Mateo (Hazen)			5523	1498
Cement, price on Stockton St. Tunnel, San Francisco (Ellis)	5522	1498		
Cement, price paid by Los Angeles in 1914 (Lippincott)			5518	1497
Cement, price paid for at Calaveras in 1914 by Spring Valley Water Co. (Lippincott)			5520	1497
Cement, quality of (Hazen)			5415	1462
Cement, there is a combination in selling (Lippincott)			5469	1480
Comparable in general way to Spaulding Dam (Hazen)			5432	1468
Compared to Croton Dam, N. Y. (Hazen)			5107	1374
Concrete, assumed cost of mixing and placing at Crystal Springs (Lippincott)			5481	1484
Concrete, comparison of costs (Hazen)			5443	1472
Concrete, cost less in Alameda System (Hazen)			5441	1471
Concrete, cost of at Government Dams (Lippincott)			5529–5530	1499
Concrete, cost of auxiliary structures (Hazen)			5417	1462
Concrete, cost of does not include rock crushing plant (Hazen)			5418	1463
Concrete, cost of in place (Hazen)			5417–5418	1462–1463
Concrete, cost of mixing and placing (Lippincott)			5479	1484
Concrete, cost of mixing and placing on Gibraltar Dam, Santa Barbara (Lippincott)			5481	1484
Concrete, cost of on Government Dams (Lippincott)			5479	1484
Concrete dams, Lippincott's experience with			5516	1495
Concrete, estimated cost of (Lippincott)			5483	1485
Concrete, estimated cost of in balance of system (Hazen)			5440	1471
Concrete, estimated cost of mixing (Lippincott)			5531	1500
Concrete, Hazen assumed modern method of making and placing			5418	1463
Concrete, Lippincott's proposed method of mixing and placing			5482	1485
Concrete material, cost of (Hazen)			5419	1463

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	Record	Abstract	Record	Abstract
CRYSTAL SPRINGS DAM (LOWER)—Continued.				
Concrete, mix assumed at Crystal Springs (Lippincott)			5468	1480
			5534	1500
Concrete, mix assumed on Government dams (Lippincott)			5528–5530	1499
Concrete, quantities and unit costs of (Hazen)			5409	1459
Concrete, will cost more than similar work (Hazen)			5420	1464
Construction, method used best at present time (Hazen)			5418	1463
Contract prices, average for Eastern dams (Hazen)			5430	1468
Cost, actual obtained from Wenzelburger's report (Greene)			5434	1469
Cost, estimated at present time practically same as estimated 25 years earlier (Hazen)			5436	1470
Cost, estimated for reproduction of (Metcalf)			5435	1470
Cost, Hazen and Lippincott's figures compared			5501	1491
			5509	1493
			5513	1495
Cost, method of computing based on Eastern experience (Hazen)			5430–5431	1468
Cost of, would be increased if joints were duplicated (Hazen)			5437	1470
Cost, segregation of, Wenzelburger's report			5434	1469
Cost, would be more than similar dam favorably situated (Hazen)			5423	1465
Dillman saw no joints in dam	5437	1470		
Equipment for handling sand, cost of (Hazen)			5415	1462
Equipment for handling sand, necessary (Hazen)			5415	1462
Excavation, cost of excavating shaft at Elizabeth Tunnel (Lippincott)			5534	1500
Excavation, cost of for tower (Lippincott)			5534	1500
Excavation, quantities and unit costs (Hazen)			5408	1459
Hauling, branch railroad could not be built economically for (Hazen)			5419	1463
Hauling concrete, total cost per cubic yard (Hazen)			5419	1463
Hauling, cost of (Lippincott)			5468	1480
Hauling material, cost of (Hazen)			5413	1461
Hauling sand, cost of (Hazen)			5416	1462
Hauling, time required (Hazen)			5413	1461
Joints discussed (Hazen)			5438	1471
Joints discussed (Dillman)	5438	1471		
Labor and material, cost of compared with Eastern work (Hazen)			5447	1474
Labor, cost of (Hazen)			5428	1467
			5443	1472
Labor, cost of on concrete (Hazen)			5418	1463

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
CRYSTAL SPRINGS DAM (LOWER)—Continued.				
Lumber, cost of at San Mateo (Lippincott)....			5478	1484
Lumber, freight paid (Lippincott)			5478	1484
Magnificent piece of masonry construction (Hazen)			5436	1470
Masonry dams, general remarks (Hazen)			5410	1459
Mix concrete, assumed by Lippincott.....			5468	1480
Overhead, administrative expense not charged against work on Los Angeles Aqueduct (Lippincott)			5506	1493
Overhead allowance for engineering expense (Lippincott)			5504	1492
Overhead and indirect expense on power dams (Lippincott)			5493	1489
Overhead assumed on other jobs (Lippincott)...			5494	1489
Overhead contingencies, explanation of (Hazen)..			5511	1494
Overhead, Crystal Springs, allowance for (Lippincott)			5503	1491
Overhead, difficult to compare from different works (Hazen)			5508	1493
Overhead, estimate of (Hazen)			5510	1494
Overhead, general remarks (Lippincott).....			5487	1487
Overhead, Gibraltar Dam, indirect expense (Lippincott)			5493	1489
Overhead, roads and trails items, Los Angeles (Lippincott)			5489	1488
Overhead, segregation of (Lippincott)			5503	1491
Overhead, what overhead and indirect expense includes (Lippincott)			5494–5502	1489–1491
Plums, none available for (Hazen)			5439	1471
Puddling, detailed cost (Lippincott)			5486	1486
Puddling, estimated cost (Lippincott)			5486	1486
Quarries, information in re location obtained from Mr. Schussler and Mr. Lawrence (Hazen)			5416	1462
Rock, cost of (Hazen)			5417	1462
Rock, detailed cost of (Lippincott)			5477	1483
.....			5527	1498
Rock, Lippincott assumed it would be quarried at dam			5527	1498
Rock, not very good quality (Hazen).....			5416	1462
Rock quarry, location of (Lippincott)			5477	1483
Rock, weight of (Lippincott)			5477	1483
Rock, would be rejected in quarrying (Hazen)..			5439	1471
Sand, amount required (Hazen)			5420	1464
Sand, cost as per letter of Spring Valley purchasing agent (Lippincott)			5475	1483
Sand, cost of (Hazen)			5415	1462
.....			5420	1464

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RYSTAL SPRINGS DAM (LOWER)—Continued.				
Sand, could be obtained from Niles Canyon (Lippincott)			5475	1483
Sand, difficulty of obtaining (Hazen)			5420	1464
Sand, estimated cost at Niles (Lippincott)			5526	1498
Sand, estimated cost at San Mateo (Lippincott)			5525	1466
Sand, obtained from North Beach, San Francisco (Dockweiler)	5474	1482		
Sand, points from where it could be obtained (Hazen)			5411	1460
Sand, sufficient quantities could not be obtained near Crystal Springs Dam (Lippincott)			5474	1482
Sand, total cost of per cubic yard on job (Lippincott)			5416	1462
Sand, weight of (Lippincott)			5476	1483
Stripping, cost of at Gibraltar Dam (Lippincott)			5484	1485
			5532	1500
Stripping, cost of at Government dam (Lippincott)			5484	1485
Stripping, cost of at Roosevelt Dam (Lippincott)			5484	1485
Stripping, description of work (Lippincott)			5531	1500
Stripping, estimated cost of (Lippincott)			5484	1485
			5531	1500
Transportation, of material difficult (Hazen)			5411	1460
Trenching, water at Howard Cut (Lippincott)			5533	1500
Tunnels, cement required for creek work (Lippincott)			5534	1500
Tunnels, high cost, reason for (Lippincott)			5485	1486
Tunnels, Lippincott assumed brick at $50 per M.			5485	1486
Tunnels, Lippincott assumed brick lined			5534	1500
Tunnels, Lippincott assumed concrete in reproduction			5534	1500
Tunnels, Lippincott figured brick in Crystal Springs only			5485	1486
Went through earthquake without injury (Hazen)			5418	1463
Wenzelburger's report adjusted to Hazen's report			5434	1469
Wenzelburger's report compared to Hazen's estimate			5436	1470
Wenzelburger's report, segregation of costs			5434	1469
CRYSTAL SPRINGS DAM (UPPER)				
Basis of estimate (Dockweiler)	5073	1365		
Bridge as substitute for present (Hazen)			5105	1374
Culverts, explanation of use of (Hazen)			5093	1370
Depreciation (Hazen)			4955	1327
			5075	1366
Depreciation (Dillman)	5075	1366		
Depreciation (Dockweiler)	5075	1365		
Dillman used same unit prices as at San Andres	5027	1351		
Discussed by (Hazen)			5106	1374
Estimating, method of (Dockweiler)	5077	1366		

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CRYSTAL SPRINGS DAM (UPPER)—Continued.				
Explanation of use of culverts (Hazen)			5092	1370
General remarks on reproduction of (Hazen)			5081–5083	1367
Has more than simple embankment value (Hazen)			5074	1365
Hazen's total estimate on			5073	1365
If dam were narrowed for road purposes would have to be rip-rapped			5093	1370
Improves quality of water (Hazen)			5105	1374
Reasons for lower unit cost of embankment (Hazen)			4954	1327
Stripping and trench work not included in volume (Hazen)			5093	1370
Total cost of (Dillman)	5073–5075	1365–1366		
(Dockweiler)	5073–5075	1365		
(Hazen)			5075	1366
Usefulness of (Hazen)			4955	1327
CRYSTAL SPRINGS PIPE LINE				
Excavation cost 50c per cubic yard (Dillman)	4423	1182		
Lawrence's analysis shows iron furnished for			4396	1174
Structure 1, unit prices (Dillman)	4422	1182		
DALLAS-WARNER FILL				
Method used in construction			5141	1384
DAMS				
Ashokan Dam (N. Y.) description of (Hazen)			5422	1464
Columbus, Ohio, description of (Hazen)			5424	1465
Cross River Dam (N. Y.), description of (Hazen)			5423	1465
Hartford, Conn., Dam, description of (Hazen)			5424	1465
Holyoke, Mass., Dam, description of (Hazen)			5425	1466
Kensico Dam, N. Y., description of (Hazen)			5421	1464
Lock Haven Dam (Baltimore), description of (Hazen)			5424	1465
Pittsfield, Mass., Dam, description of (Hazen)			5424	1465
Springfield, Mass., Dam, description of (Hazen)			5424	1465
Wachusetts Dam (Boston), description of (Hazen)			5423	1465
DAMS, CONCRETE				
Lippincott's experience with			5516	1495
DAMS, EARTH				
Alamo Dam, cost of Fresno scrapers with drivers (Herrmann)			5140	1384
Alamo Dam, Imperial Valley, dimensions of (Herrmann)			5140	1384
Alamo Dam, Imperial Valley, material was not selected (Herrmann)			5141	1384
Alamo Dam, Imperial Valley, method of construction (Herrmann)			5140	1384
Alamo River Dam, cost of (Herrmann)			4970	1333
Appraisal conditions considered (Herrmann)			4961	1330
Benching, description of at Pilarcitos (Dillman)	5025	1350		

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DAMS, EARTH—Continued.				
Benching, no allowance made for at Pilarcitos (Herrmann)			4987	1340
			5136	1383
Benching, no allowance made for at Pilarcitos (Dockweiler)	5059	1361		
Blue Lakes, embankment cost greater than at Tabeaud (Ellis)	5255	1419		
Borden Brook Dam construction compared to Pilarcitos and San Andres (Hazen)			5083	1367
Borden Brook Dam, Springfield, Mass., total cost of (Hazen)			4946	1323
Borrow pits, Pilarcitos, discussion of in re Ebright's information as to location			5400	
Borrow pits, Pilarcitos, discussion of in re Ebright's information as to location (Dockweiler)	5399	1458		
Borrow pits, location of near Pilarcitos (Dockweiler)	5053	1359		
	5197	1401		
Borrow pits, location of did not influence figures (Ellis)	5237	1414		
Borrow pits, Tabeaud Dam (Ellis)	5251–5252	1418		
Borrow pits, Tabeaud Dam, location of (Ellis)	5243	1416		
Borrow pits, Wild Horse Dam No. 2 (Vallejo, Cal.) haul from (Noyes)	5270	1424		
Breaks, earth dams go out by under-mining when there is seepage underneath (Hazen)			5183	1397
Breaks, old earth dams go out by over-topping through squirrel holes, and no other reason (Dockweiler)	5182	1397		
Brickwork, difference in unit costs (Herrmann)			4998	1342
Bridge as substitute for present Crystal Springs Upper Dam (Hazen)			5105	1374
Calaveras, capacity of steam shovel dipper is right (Hazen)			5152	1388
Calaveras, some of the work done in a rush (Herrmann)			5145	1386
Calaveras, stripping of Freeman site rushed (Herrmann)			5151	1388
Calaveras, work retarded by litigation (Herrmann)			5149	1387
Calaveras Dam, resume of work (Elliott)			5394	1456
Calaveras, unit costs of (Herrmann)			4973	1334
Central Reservoir—Oakland—construction was under charge of George Wilhelm (Dockweiler)	5203	1403		
Central Reservoir, description of puddle core and trench (Dockweiler)	5200	1402		
Central Reservoir, four men are on payroll whether shovel works or not (Dockweiler)	5189	1399		

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DAMS, EARTH—Continued.				
Central Reservoir, embankment was rolled (Dockweiler)	5163	1392		
Central Reservoir, number of days worked and elapsed time for steam shovel work (Dockweiler)	5188	1399		
Central Reservoir, puddle core above surface (Dockweiler)	5200	1402		
Central Reservoir, record of steam shovel work (Dockweiler)	5201	1402		
Central Reservoir, rental cost of steam shovel and wages of crew (Dockweiler)	5040	1355		
Central Reservoir, steam shovel work supporting data for estimate of 900 yards per day at Pilarcitos (Dockweiler)	5202	1402		
Central Reservoir, steam shovel worked 139 days out of 212 (Dockweiler)	5044	1356		
Central Reservoir, was built without a puddle core (Dockweiler)	5163	1392		
Clearing, contract Hetch-Hetchy about $35 per acre (Searls)	5101	1373		
Clearing, cost of, Calaveras Dam (Herrmann)			4965	1331
			5118	1378
Clearing, cost of, Calaveras-Sunol Road (Herrmann)			4964	1331
Clearing, cost of, Colorado River levee sites (Herrmann)			4963	1330
			5121	1379
Clearing, cost of, in the East (Hazen)			4954	1327
			5099	1372
Clearing, cost of, roads and trails at Calaveras (Hazen)			5118	1378
Clearing, cost of, San Andres Dam (Hazen)			4953	1326
Clearing, eastern costs applied to California conditions (Hazen)			5099	1372
Clearing, method of estimating cost at Calaveras (Herrmann)			5119	1378
Clearing, Pilarcitos Reservoir cost 15% more than Calaveras (Herrmann)			4965	1331
Clearing, rate paid (Hazen)			5100	1373
Clearing site, unit cost based on contractor's figures near Woodside (Dockweiler)	5030	1352		
Clearing, unit costs (Dillman)	5013	1347		
Clearing, unit costs (Herrmann)			4963	1330
Colma Dam more costly than San Mateo Dams (Hazen)			4956	1328
Compacting, Dockweiler considers necessary	5199	1402		
Concrete and puddle trench, unit costs (Herrmann)			4986	1340
Concrete frames a part of concrete cost (Dillman)	5168	1393		

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DAMS, EARTH—Continued.				
Concrete, unit costs (Dillman)	5025	1350		
	5028			
Concrete, unit costs (Herrmann)	4986	1340		
Conditions in California compared to Eastern (Hazen)			4948	1324
Construction, difference Pilarcitos and Calaveras Dams (Hazen)			5109	1375
Construction, general remarks on (Hazen)			4945	1322
Construction, Los Angeles Dams not comparable to Pilarcitos (Herrmann)			5114–5115	1376–1377
Construction, methods assumed at Pilarcitos Dam (Hazen)			5109	1375
Construction, methods assumed at Pilarcitos Dam (Elliott)			5390	1454
Construction, methods assumed in estimating costs (Herrmann)			4974	1335
Construction, methods used at Borden Brook Dam, Springfield, Mass. (Hazen)			4947	1323
Construction, method used at Calaveras (Herrmann)			4973	1334
Construction, methods used at Calaveras Dam (Hazen)			5109	1375
Construction, methods used at Drum forebay (Herrmann)			5127	1380
Construction of and material used, Borden Brook Dam (Springfield, Mass.) (Hazen)			5083–5085	1367–1368
Construction of, by hydraulic fill methods (Hazen)			4958	1328
Contract let for clearing Hetch-Hetchy about $35 per acre (Searls)	5101	1373		
Contract, original on Pilarcitos Dam discussed by Dockweiler	5104	1373		
Cost and character of work at Springfield, Mass. (Hazen)			5095	1371
Cost details (Dillmann)	5013	1347		
Cost 5c per yd. more to handle material with steam shovel than with New Era Grader (Dillman)	5288–5291	1428–1429		
	5294			
Cost difference in Pilarcitos and San Andres (Hazen)			5068–5069	1363–1364
Cost, familiar with on Calaveras Dam (Hazen)			4957	1328
Cost, Los Angeles Aqueduct not any cheaper than the Hazen method			4958	1328
Cost, no attention paid to original cost of Pilarcitos and San Andres Dams in 1913 estimate (Hazen)			5111	1375
Crystal Springs Dam, Upper, compared with Croton Dam, N. Y. (Hazen)			5107	1374

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	Record	Abstract	Record	Abstract
DAMS, EARTH—Continued.				
Crystal Springs Dam, Upper, depreciation (Dillman)	5075	1366		
Crystal Springs Dam, Upper, depreciated 60% (Hazen)			4955	1327
			5075	1366
Crystal Springs Dam, Upper, depreciated totals (Dockweiler)	5075	1365		
Crystal Springs Dam, Upper, Dillman used same unit prices as at San Andres	5027	1351		
Crystal Springs Dam, Upper, discussed by Hazen.			5106	1374
Crystal Springs Dam, Upper, Dockweiler's basis for estimate	5073	1365		
Crystal Springs Dam, Upper, Dockweiler's method of estimating	5077	1366		
Crystal Springs Dam, Upper, has more than simple embankment value (Hazen)			5074	1365
Crystal Springs Dam, Upper, improves quality of water (Hazen)			5105	1374
Crystal Springs Dam, Upper, reproduction of (Hazen)			5081–5083	1367
Crystal Springs Dam, Upper, total cost (Dillman)	5073–5075	1365-1366		
Crystal Springs Dam, Upper, total cost (Dockweiler)	5073	1365		
Crystal Springs Dam, Upper, total cost (Hazen)			5073–5075	1365–1366
Crystal Springs Dam, Upper, utility of (Hazen)			4955	1327
Crystal Springs Dam, Upper, if narrowed for road purposes it would have to be rip-rapped (Hazen)			5093	1370
Culverts, explanation of use of in Crystal Springs Upper Dam (Hazen)			5092	1370
Difference in Dockweiler's and Hazen's unit costs between Pilarcitos and San Andres Dams.	5066–5068	1363		
Difference in trenching cost between San Andres and Pilarcitos Dams (Dockweiler)	5068	1364		
Difference in units between San Andres and Pilarcitos (Dillman)	5026	1351		
Dillman could obtain no information from Schussler	5167	1393		
Dillman had experience in steam shovel work, scrapers, etc. (Dillman)	5012	1347		
Dockweiler did not make computations on actual time steam shovel worked on Central Reservoir, Oakland	5041	1356		
Dockweiler explanation of unit costs, San Mateo Creek Dam No. 1	5078	1366		
Dockweiler familiar with Central Reservoir Dam, Oakland, Calif.	5030	1352		

DAMS, EARTH—Continued.	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
Dockweiler familiar with costs on Los Angeles aqueduct	5029	1352		
Dockweiler has read literature on the subject of	5030	1352		
Dockweiler has record of steam shovel work on Franklin Canyon Dam	5033	1353		
Dockweiler studied history of Spring Valley Dams	5029	1352		
Dockweiler units at San Andres compared with Hazen's and Herrmann's	5072	1365		
Drain pipes, item 15, page 3			5061	1362
Drum forebay, average working time same as at Pilarcitos (Herrmann)			5134	1382
Drum forebay costs comparable with estimates on Pilarcitos (Herrmann)			5133	1382
Drum forebay, cost does not include overhead (Herrmann)			5133	1382
Drum forebay, cost of (Herrmann)			4969	1333
Drum forebay, difference in climate and location would increase price for work at Pilarcitos (Herrmann)			5133	1382
Drum forebay, dimensions of (Herrmann)			5126	1380
Drum forebay, embankment comparable to Pilarcitos (Herrmann)			5130	1381
Drum forebay, embankment has no puddle core (Herrmann)			5136	1383
Drum forebay, location of (Herrmann)			5126–5134	1380–1382
Dry Canyon Dam, cost of (Herrmann)			4971	1334
Dry Canyon Dam, cost of puddling (Dockweiler)	5062	1362		
Embankment, class of material used in Pilarcitos Dam (Hazen)			5086	1368
Embankment, construction, proposed method of (Ellis)	5239	1415		
Embankment, Dillman considered use of steam shovel in his estimates	5014	1348		
Embankment, contract price of Borden Brook Dam, Springfield, Mass. (Hazen)			4946	1323
Embankment, cost of drum forebay (Herrmann)			5130	1381
Embankment, Dillman did not consider grooved rollers, etc., as necessary	5014	1348		
Embankment, Drum forebay comparable to Pilarcitos (Herrmann)			5136	1383
Embankment, estimated cost for Pilarcitos Dam (Hazen)			4948	1324
Embankment, estimated cost for San Andres Dam (Hazen)			4948	1324
Embankment, methods of separating material for (Hazen)			5096	1371
Embankment on Pilarcitos and San Andres Dams, estimated cost of (Ellis)	5231	1412		

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	Record	Abstract	Record	Abstract
DAMS, EARTH—Continued.				
Embankment, percentage of shrinkage in materials (Ellis)	5238	1414		
Embankment, reasons for lower unit cost on Upper Crystal Springs Dam (Hazen)			4954	1327
Embankment, Tabeaud portion of most expensive (Ellis)	5245	1416		
Embankment, unit costs (Dillman)	5013	1347		
Equipment at Calaveras used to fair capacity (Hazen)			5152	1388
Excavation, South Haiwee Dam, L. A., cost of (Herrmann)			5116	1377
Experience, Dillman never built any high earth dams	5011	1346		
Experience, saw construction of last portion of San Leandro Dam (Dillman)	5011	1346		
Exploration expense not included in Pilarcitos estimate (Herrmann)			4993	
			5117	1378
Exploration, not covered by overhead (Hazen)			4993	
Exploration, on Pilarcitos Dam not shown in inventory (Greene)			4992	1341
Exploration, should not go into overhead (Herrmann)			4993	
Exploration will be carried by the unit figures (Metcalf)			4993	
Extract from report of Calvin Brown of Spring Valley on Pilarcitos site (Searls)	5253	1419		
Field costs, depreciation of equipment not a field cost (Herrmann)			5150	1388
Fill, cost at Calaveras Dam (Hazen)			5110	1375
Fill, hydraulic, Modesto Irrigation District, cost of (Herrmann)			4972	1334
Franklin and San Fernando Dams visited by Elliott			5404	1458
Haiwee Dam (North) L. A. Aqueduct cost of (Herrmann)			4971	1334
Haiwee Dam (South) L. A. Aqueduct cost of (Herrmann)			4971	1334
Hauling from steam shovel at Calaveras (Herrmann)			4967	1332
Hauling material from steam shovel at Calaveras, cost of (Herrmann)			4966–4967	1332
Hauling rip-rap and cost of placing (Dockweiler)	5058	1361		
Hauling unit costs (Dockweiler)	5047	1357		
Hetch-Hetchy, contract for clearing about $35 per acre (Searls)	5101	1373		

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	Record	Abstract	Record	Abstract
DAMS, EARTH—Continued.				
Howard Cut, paved on one face not rip-rapped (Hazen)			4953	1326
Indirect charges, L. A. Aqueduct, explained by Herrmann			5111–5114	1376
Labor, comparison in efficiency for 8 and 10 hour day (Ellis)	5233	1413		
Labor, comparison of costs East and West (Hazen)			5087	1368
Labor, cost etc., Borden Brook Dam, Springfield, Mass. (Hazen)			5087	1368
Labor, cost and class of on Colo. River levees (Herrmann)			4963	1331
Labor, costs obtained from S. P. payrolls (Hazen)			5097	1371
Labor, Dockweiler figured on 9-hour day at Pilarcitos	5207	1404		
Labor, efficiency, etc., general remarks (Ellis)	5257–5260	1420-1421		
Labor, eight hour day used as basis in estimating (Hazen)			5100	1372
Labor, eight hours in San Mateo, and ten hours in Calaveras (Herrmann)			4964	1331
Labor, Hazen's assumed cost etc., on Pilarcitos Dam			5089	1369
Labor, hours, etc., employed in East for clearing (Hazen)			5100	1372
Labor, on Drum forebay, cost of (Herrmann)			5130	1381
Labor, on Los Angeles Aqueduct (Herrmann)			5126	1380
Labor, ordinary white labor will do nearly twice as much as Mexican labor (Dillman)	5016	1348		
Labor, time worked in East on clearing (Hazen)			5100	1372
Labor, unions, etc., general remarks by Hazen			5090–5091	1369–1370
Labor, wages for trenching (Dockweiler)	5050	1358		
Labor, wages paid for clearing (Hazen)			5099	1372
Labor, wages $2.50 per day in 1913 (Dillman)	5015	1348		
Labor, wage schedule used in estimating Peninsula dams (Herrmann)			4973	1334
Labor, would be employed 10 hours a day and not less than 9 hours (Dillman)	5015	1348		
Lake Arthur Dam, material used in construction			5138	1383
Lake Arthur Dam, not as high as Pilarcitos or San Andres (Herrmann)			5139	1384
Lake Arthur Dam, Pac. Gas & Elec. Co., cost of (Herrmann)			4970	1333
Lake Valley Dam, dimensions (Herrmann)			5137	1383
Lake Valley Dam, Pac. Gas & Elec. Co., cost of (Herrmann)			4970	1333
La Mesa Dam, San Diego County, Dillman made report on to New England Trust Co.	5012	1347		

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	Record	Abstract	Record	Abstract
DAMS, EARTH—Continued.				
Leakage, half a hundred dams Hazen knows of leaked more or less seriously			5183	1397
Leakage, none in Wild Horse Dam No. 2, (Vallejo, Cal.) (Noyes)	5265	1423		
Leakage, quite common in (Dillman)	5175	1395		
Leakage, such a dam as I propose at Pilarcitos would probably leak (Dillman)	5175	1395		
Loading and operating wagons, method used at Calaveras Dam (Elliott)			5391	1455
Los Angeles Aqueduct, capacity of steam shovel at Franklin Canyon (Dockweiler)	5034	1353		
	5192	1399		
Los Angeles Aqueduct, cost of puddle fill, Dry Canyon Dam (Dockweiler)	5199	1402		
Los Angeles Aqueduct, dams, cost of (Herrmann)			4971	1333
Los Angeles Aqueduct, detail of haul at Franklin Canyon Dam (Dockweiler)	5033	1333		
Los Angeles Aqueduct, Dockweiler does not know what the material was on Dry Canyon Dam	5191	1399		
Los Angeles Aqueduct, Dockweiler has detail cost	5033	1353		
Los Angeles Aqueduct, Franklin Canyon Dam was permanent work (Dockweiler)	5190	1399		
Los Angeles Aqueduct, letters from Mr. H. L. Jacques in re steam shovel output (Dockweiler)	5034	1353		
Los Angeles Aqueduct, material used on Franklin Canyon Dam (Dockweiler)	5191	1399		
Los Angeles Aqueduct, method of blasting at San Fernando in steam shovel pit (Dockweiler)	5198	1401		
Los Angeles Aqueduct, method of construction of Franklin Canyon Dams (Dockweiler)	5194	1400		
Los Angeles Aqueduct, record of steam shovel work on Franklin Canyon Dam (Dockweiler)	5037	1354		
Los Angeles Aqueduct, steam shovel output based on an average (Dockweiler)	5033	1353		
Materials, compacting of at Calaveras Dam (Elliott)			5391–5395	1455–1456
Materials, could not segregate economically with steam shovel at Pilarcitos (Elliott)			5396	1457
Materials, handled by wagon-loads on L. A. Aqueduct cannot be computed (Elliott)			5405	1458
Materials, that could be used at Calaveras and Pilarcitos (Elliott)			5398	1457
Materials, rolled in 12" layers, seen by (Ellis)	5239	1415		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
DAMS, EARTH—Continued.				
Modesto Irrigation District, contract price for puddling (Herrmann)			4984	1339
Modesto Irrigation District, cost of embankment (Herrmann)			5142	1385
Modesto Irrigation District, cost of trenching (Herrmann)			5155	1389
Modesto Irrigation District, dimensions of dam (Herrmann)			5142	1385
Modesto Irrigation District, method used in building Dallas-Warner fill (Herrmann)			5141	1384
Modesto Irrigation District, wage schedule (Herrman)			5142	1385
Modesto Irrigation District, work partly paid for in bonds (Herrmann)			5142	1385
New Era Graders, capacity of (Dillman)	5288	1428		
New Era Graders, and steam shovels compared as to capacity (Noyes)	5293	1429		
New Era Graders, description of (Noyes)	5274	1425		
New Era Graders, 39,000 cu. yds. moved in 61 days (Metcalf)			5310	1433
New Era Graders, will not handle more material than steam shovel (Dillman)	5291	1429		
Overhead, employers liability insurance (Dockweiler)	5047	1357		
Overhead, not included in estimate on Pilarcitos Dam (Herrmann)			5116	1377
Overhead, office should be added to indirect charges on L. A. Aqueduct (Herrmann)			5112	1376
Pacific Gas & Elec. Co. Dams, Dockweiler familiar with	5030	1352		
Pilarcitos and Calaveras Dams water supply (Herrmann)			5115–5116	1377
Pilarcitos and San Andres are as fine as any dams in the country (Herrmann)			4990	1341
Pilarcitos and San Andres Dams, estimates based on experience (Hazen)			4945	1322
Pilarcitos and San Andres Dams, examination of (Ellis)	5230			
Pilarcitos and San Andres Dams, unit costs the same (Herrmann)			4963	1330
Pilarcitos and San Andres Dams, would take two years to reproduce (Hazen)			5083	1367
Pilarcitos borrow pits, location of (Dockweiler)	5053	1359		
Pilarcitos contract, original discussed by (Dockweiler)	5104	1373		
Pilarcitos, contractor's profit allowed (Ellis)	5253	1419		
Pilarcitos, cost of placing material with steam shovel less than with scrapers (Ellis)	5235	1413		

DAMS, EARTH—Continued.	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
Pilarcitos, cost to ship steam shovel into (Dockweiler)	5130			
Pilarcitos, Dam could not be reproduced with steam shovel (Elliott)			5398	1457
Pilarcitos Dam, date of construction (Hermann)			4990	1341
Pilarcitos Dam, Elliott would built with scrapers			5397	1457
Pilarcitos Dam, estimated cost (Herrmann)			4973	1334
Pilarcitos Dam, estimated cost (Hazen)			4948	1324
Pilarcitos Dam, leaks were in rock, and had nothing to do with the dam (Herrmann)			4991	1341
Pilarcitos Dam, (old) out of use, and not considered by Hazen			4956	1328
Pilarcitos Dam, percentage of labor cost (Herrman)			5144	1385
Pilarcitos Dam, quantities (Hazen)			4949	1324
Pilarcitos Dam, quantities (Herrmann)			4975	1335
Pilarcitos Dam, total estimate (Hazen)			4949	1324
Pilarcitos Dam, would be built differently than the Calaveras Dam (Hazen)			5109	1375
Pilarcitos Dam, detailed unit costs (Ellis)	5232	1412		
Pilarcitos Dam, difference between cost of puddling at, and San Andres (Dockweiler)	5070	1364		
Pilarcitos Dam, difference in Dockweiler's and Hazen's costs at San Andres	5066–5068	1363		
Pilarcitos, Dillman assumed he could not encounter any hard rock in trench	5173	1394		
Pilarcitos, Dillman assumed capacity of steam shovel	5171	1394		
Pilarcitos, Dillman says not much powder could be used	5171	1394		
Pilarcitos, Dillman spent less than 10 hours in examination	5169	1393		
Pilarcitos, Dillman would use derrick in construction of trench	5173	1394		
Pilarcitos, Dockweiler made allowance of 10% for layoff	5042	1356		
Pilarcitos, estimate of delays on steam shovel work (Dockweiler)	5204	1403		
Pilarcitos, extract from report of Calvin Brown (Searls)	5253	1419		
Pilarcitos, location of borrow pits, and extent of fall (Dockweiler)	5197	1401		
Pilarcitos, material in vicinity could be handled very comfortably with steam shovels (Dillman)	5170	1393		
Pilarcitos, method of getting in steam shovel (Dillman)	5180	1396		

DAMS, EARTH—Continued.	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
Pilarcitos, method of puddling (Dillman)	5159	1390		
Pilarcitos, reproduction of (Hazen)			5403	
Pilarcitos reservoir—purpose of (Herrmann)			5121	1379
Pilarcitos, selection of material (Dillman)	5158	1390		
Pilarcitos, steam shovel could work there advantageously (Dockweiler)	5197	1401		
Pilarcitos, trenching cost, difference between, and San Andres (Dockweiler)	5068	1364		
Pilarcitos, type of structure estimated by Dillman	5175	1395		
Pilarcitos, unit prices concrete in puddle trench (Dockweiler)	5057	1361		
Pilarcitos, was not important for Dillman's estimate to know depth of puddle trench	5166	1392		
Pilarcitos, weight per cu. yd. puddle core (Dillman)	5160	1391		
Pilarcitos, would not pay for teams during delays and layoffs (Dockweiler)	5205	1403		
Pilarcitos District, examination of (Ellis)	5236	1414		
Powder not much used at San Andres (Dockweiler)	5154	1389		
Power, cost of per cu. yd. of excavation (Herrmann)			5154	1389
Power, cost of at Calaveras			5122-5123	1379
Power plant, cost of at Calaveras (Herrmann)			5123	1379
Proposed methods of reproduction of Pilarcitos and San Andres Dams (Ellis)	5232	1412		
Puddle at San Andres, Dockweiler's method of handling	5070	1364		
Puddle core, Dockweiler has never seen a puddle core put in	5201	1402		
Puddle core, weight per cu. yd., Pilarcitos (Dillman)	5160	1391		
Puddle wall, through Tabeaud Dam was abandoned (Ellis)	5228	1410		
Puddling, and distance of haul on Pilarcitos Dam (Dockweiler)	5056	1361		
Puddling, description of (Dillman)	5025	1350		
Puddling, detail estimate Modesto Irrigation District (Herrmann)			4984	1339
Puddling, general remarks (Hazen)			4953	1326
Puddling, is not always necessary in dams (Dillman)	5026	1351		
Puddling, is not necessary if material of dam is compacted (Dillman)	5162	1391		
Puddling, location of borrow pits, Pilarcitos Dam (Dockweiler)	5054	1360		
Puddling, method of, Pilarcitos (Dillman)	5159	1390		

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Puddling, Modesto Irrigation District, method of (Herrmann)			4984	1339
Puddling, Pilarcitos Dam (Herrmann)			4983–4984	1338–1339
Puddling, Pilarcitos Dam, unit cost (Hazen)			4956	1328
Puddling, San Andres Dam (Herrmann)			4983–4984	1338–1339
Puddling, supporting data from L. A. Aqueduct (Dockweiler)	5062	1362		
Puddling, twelve inch layers used on Pilarcitos Dam (Searls)	5244	1416		
Puddling, unit cost (Dillman)	5023–5028	1350–1351		
Puddling, unit cost (Dockweiler)	5056–5071	1361–1365		
Puddling, unit cost (Hazen)			4953	1326
Puddling, unit cost, San Andres Dam (Hazen)			4953	1326
Rip-rap at San Andres better than at Pilarcitos (Herrmann)			4987	1340
Rip-rap, character of, Wild Horse Dam No. 2 (Vallejo, Cal.) (Noyes)	5268	1424		
Rip-rap, contract prices on Modesto Irrigation District (Herrmann)			5353	1442
Rip-rap, cost of quarrying, Pilarcitos Dam (Dockweiler)	5058	1361		
Rip-rap, examination of on Pilarcitos Dam (Hazen)			4952	1326
Rip-rap for Pilarcitos and San Andres Dams, does not know where obtained (Herrmann)			5359	1444
Rip-rap, loose, unit cost (Herrmann)			4987	1340
Rip-rap, Modesto Irrigation District comparable to Pilarcitos and San Andres (Herrmann)			5354	1443
Rip-rap, Modesto Irrigation District not comparable to Howard Cut (Herrmann)			5355	1443
Rip-rap, Pilarcitos, average thickness of (Hazen)			5455	1476
Rip-rap, Pilarcitos Dam, unit cost (Dockweiler)	5058	1361		
Rip-rap, Pilarcitos Dam, general remarks (Herrmann)			5272	1425
Rip-rap, quarries, Pilarcitos Dam, location of (Dockweiler)	5058	1361		
Rip-rap, specifications for Modesto Irrigation District work (Herrmann)			5359	1444
Rip-rap, suitable material more available on Modesto works than at Pilarcitos and San Andres (Herrmann)			5359	1444
Rip-rap, unit cost (Herrmann)			4987	1340
Rip-rap, unit cost (Dillman)	5025	1350		
Rip-rap, various bids for Modesto Irrigation District work (Herrmann)			5358	1444
Rip-rap, Wild Horse Dam, did not include quarrying (Herrmann)			5356	1444

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Rip-rap, Wild Horse Dam No. 2, cost of (Noyes)	5273	1425		
Rip-rap, Wild Horse Dam No. 2, laid in gravel (Noyes)	5271	1425		
Roads and trails at Pilarcitos (Herrmann)			5117	1378
Rock facing on Tabeaud Dam placed by contractor (Ellis)	5226	1409		
Rolling, method used at Tabeaud Dam (Ellis)	5257	1420		
Rolling, one cent allowed for water for (Ellis)	5257	1420		
San Andres, cost of placing material with steam shovel less than with scrapers (Ellis)	5235	1413		
San Andres, detailed unit costs (Ellis)	5232	1412		
San Andres, difference between Dockweiler's and Hazen's unit cost and Pilarcitos	5066–5068	1363		
San Andres, difference between cost of puddling at and Pilarcitos (Dockweiler)	5070	1364		
San Andres, Elliott did not study formation of			5407	1458
San Andres, estimated cost (Hazen)			4950	1325
San Andres, estimated cost (Herrmann)			4973	1334
San Andres, examination of (Ellis)	5230			
San Andres, quantities (Hazen)			4950	1325
San Andres, quantities (Herrmann)			4975	1335
San Andres, total estimate (Hazen)			4950	1325
San Andres, unit costs compared to those used at Pilarcitos (Dockweiler)	5066–5068	1363–1364		
San Leandro, familiar with (Dockweiler)	5029	1352		
San Leandro, work was very expensive (Dillman)	5011	1347		
San Mateo Dam No. 1, Dillman's detail estimate	5028	1351		
San Mateo Dam No. 1, not of any special value to the works (Dillman)	5028	1351		
San Mateo Dam No. 1, purpose of (Dockweiler)	5079	1366		
San Mateo Creek Dams discussed			5079–5081	1366–1367
San Mateo Creek, same unit prices as Pilarcitos and San Andres (Hazen)			4956	1328
Schussler's testimony, Dockweiler familiar with	5029	1352		
Settling, core wall would settle with embankment (Dillman)	5177	1395		
Settling, of Pilarcitos Dam more than Tabeaud Dam (Ellis)	5241	1415		
Settling of Tabeaud Dam (Ellis)	5235–5241	1413–1415		
Settling, percentage of in railroad embankments (Dillman)	5165	1392		
Settling, percentage of settlement in puddle core and embankment (Dillman)	5164	1392		
Settling, possible to build dams that will not settle (Hazen)			5185	1398
Settling, quotations from Schussler's report in re settling of Pilarcitos Dam	5178	1396		

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Settling, well-built dam would not settle appreciably (Hazen)			5177	1395
			5184	1397
Shrinkage of material in embankments (Dillman)	5160	1391		
Spreading material, method of explained (Ellis)	5240	1415		
Steam shovels, Calaveras figures used as a basis for estimate			5146	1386
Steam shovels, capacity, lower Franklin Dam (Elliott)			5384	1453
Steam shovels, capacity of at Calaveras (Herrmann)			4978	1336
Steam shovels, capacity of (Dillman)	5288–5289	1428		
	5294–5295	1429		
Steam shovels, capacity of, assumed by (Dockweiler)	5208	1404		
Steam shovels, capacity San Fernando Dam (L. A.) (Elliott)			5384	1453
Steam shovels, capacity worked on a 260 day per year efficiency basis (Dockweiler)	5210	1404		
Steam shovels, conditions under which will work (Elliott)			5385–5386	1453
Steam shovels, cost of operating (Dockweiler)	5043–5047	1356–1357		
	5211	1404		
Steam shovels, cost of operating (Dillman)	5292	1429		
Steam shovels, cost of operating at Calaveras (Herrmann)			4979	1337
Steam shovels, cost of placing material at Calaveras (Herrmann)			5143	1385
Steam shovels, cost of transporting (Herrmann)			4977	1336
Steam shovels, cost of transporting Calaveras (Herrmann)			4978	1336
Steam shovels could not be taken into Pilarcitos on existing roads (Herrmann)			5046	1357
Steam shovels could be taken into Pilarcitos over existing roads (Dockweiler)	5047	1357		
Steam shovels, delivery at San Fernando Dam (L. A.) (Elliott)			5383	1452
Steam shovels, delivery at Upper Franklin Dam (L. A.) (Elliott)			5384	1453
Steam shovels, detail of transporting to San Andres and Pilarcitos (Dockweiler)	5047	1357		
Steam shovels, Dockweiler's estimate would take care of lay-offs at Pilarcitos	5041	1356		
Steam shovels, Dockweiler has frequently seen two dipper loads per minute	5209	1404		
Steam shovels, Dockweiler says you might get 3 or 4 swings a minute with dipper	5207	1404		

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Steam shovels, Ellis has had no experience in loading wagons with	5236	1414		
Steam shovels, estimate on basis of operating 300 days a year (Dockweiler)	5044	1356		
Steam shovels, estimated capacity for embankment work (Dillman)	5014	1348		
Steam shovels, Hazen assumed use of in reproduction of Pilarcitos Dam			4949–4950	1324–1325
Steam shovels, material worked by, on L. A. Aqueduct (Elliott)			5385	1453
Steam shovels, method of figuring cost (Dockweiler)	5042	1356		
Steam shovels, method of getting shovel into Pilarcitos (Dillman)	5180	1396		
Steam shovels, method of getting shovel into Pilarcitos (Dockweiler)	5187	1398		
Steam shovels, method of operating at Calaveras (Herrmann)			4978	1336
Steam shovels, never runs 100% of the time (Hermann)			5147	1386
Steam shovels, not used on Wild Horse Dam No. 2 (Vallejo, Cal.) (Noyes)	5262	1422		
Steam shovels, output, Los Angeles letter from H. J. Jacques (Dockweiler)	5034	1353		
Steam shovels, percentage of time lost at Calaveras (Herrmann)			5145–5148	1386–1387
Steam shovels, Pilarcitos conditions are favorable for (Dillman)	5014	1348		
Steam shovels, Pilarcitos, estimated output by (Dockweiler)	5042	1356		
Steam shovels, present cost of work at Calaveras Dam (Hazen)			5110	1375
Steam shovels, quantities assumed in estimating (Dockweiler)	5038	1355		
Steam shovels, 6.3c per cu. yd. for handling material (Dockweiler)	5045	1357		
Steam shovels, size of used on Central Reservoir, Oakland (Dockweiler)	5186	1398		
Steam shovels, type assumed by Dockweiler at Pilarcitos	5186	1398		
Steam shovels, will load more rapidly into cars than with wagons (Ellis)	5236	1414		
Steam shovels, work, Central Reservoir, Oakland, record of (Dockweiler)	5201	1402		
Steam shovels, work, actual cost and estimate, Calaveras Dam (Elliott)			5384–5387	1453–1454
Steam shovel work at Calaveras very difficult (Elliott)			5386	1453

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Steam shovel work, Pilarcitos compared with Calaveras (Elliott)			5397	1457
Steam shovel work, conditions at Pilarcitos and San Andres not comparable to San Fernando and Franklin Dams (Elliott)			5389–5390	1454
Steam shovel work conditions at San Fernando and Franklin Dams better than at Calaveras (Elliott)			5386	1453
Steam shovel work, cost of at Calaveras (Herrmann)			4970	1333
Steam shovel work, delays not recorded on L. A. Aqueduct (Elliott)			5405	1458
Steam shovel work, Elliott has had advantage of Mulholland's and others' advice on Calaveras			5387	1454
Steam shovel work, estimate on delays, Pilarcitos (Dockweiler)	5204	1403		
Steam shovel, would be very expensive to get into Pilarcitos (Herrmann)			5129	1381
Stock, estimated cost of (Ellis)	5254	1419		
Stock, rental cost at Calaveras (Herrmann)			5140	1384
Stock, Spring Valley Water Co. cared for and fed at Calaveras (Herrmann)			5141	1384
Stone facing on Tabeaud Dam was not hand laid rip-rap (Ellis)	5226	1410		
Stripping and trench work not included in estimate of Crystal Springs Upper Dam (Hazen)			5093	1370
Stripping by hydraulic process at Calaveras estimated (Herrmann)			4967	1332
Stripping, cost of at Calaveras (Hermann)			4966	1331
			5122–5123	1379
Stripping, cost of at Calaveras borrow pits (Herrmann)			5122	1379
Stripping, cost of at Pilarcitos (Herrmann)			5122–5123	1379
Stripping, estimate for Pilarcitos Dam (Hazen)			4949	1324
Stripping, estimated cost of Pilarcitos and San Andres Dams (Ellis)	5232	1412		
Stripping, method of (Herrmann)			5122	1379
Stripping, method of estimating cost of at Pilarcitos (Herrmann)			5124–5125	1379–1380
Stripping, Pilarcitos Reservoir, unit costs (Herrmann)			4965–4966	1331
Stripping, unit cost and method of computing (Dockweiler)	5031	1352		
Tabeaud Dam, built by E. B. & A. L. Stone Co. (Ellis)	5223	1408		
Tabeaud Dam, borrow pits (Ellis)	5251–5252	1418		
Tabeaud Dam, character of material (Ellis)	5243	1416		
Tabeaud Dam, contract price for (Ellis)	5224	1409		

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Tabeaud Dam, contractors compelled to live up to the specifications (Ellis)	5250	1418		
Tabeaud Dam, contractors did not lose money (Ellis)	5243	1416		
Tabeaud Dam, contractor had no cost for water (Ellis)	5246	1417		
Tabeaud Dam, dimensions of (Ellis)	5230	1411		
	5252	1418		
Tabeaud Dam, does not know complete cost (Ellis)	5245	1416		
Tabeaud Dam, extracts from specifications of (Ellis)	5225–5228	1409–1411		
Tabeaud Dam, familiar with construction of (Ellis)	5224	1409		
Tabeaud Dam, general remarks on road, labor, etc. (Ellis)	5248–5250	1417–1418		
Tabeaud Dam, method of construction (Ellis)	5224	1409		
Tabeaud Dam, no trouble with water during construction (Ellis)	5246	1417		
Tabeaud Dam, puddling cost (Ellis)	5245	1416		
Tabeaud Dam, reasons for rigid specifications (Ellis)	5230	1411		
Tabeaud Dam, reported on by Schuyler (Ellis)	5228	1411		
Tabeaud Dam, total yardage (Ellis)	5244	1416		
Tabeaud Dam, was built without puddle (Dillman)	5181	1396		
Tabeaud Dam, working seasons at (Ellis)	5234	1413		
Teams, detail cost of (Dockweiler)	5205	1403		
Teams, Pilarcitos, estimated cost of (Ellis)	5254	1419		
Timbering, cost of at Pilarcitos and San Andres (Dillman)	5156	1389		
Timbering, detail of cost (Dockweiler)	5050	1358		
Timbering, estimate based on Emery's testimony and Spring Valley records (Dockweiler)	5051	1359		
Trenching, character of material shown by inspection below Pilarcitos (Dockweiler)	5052	1359		
Trenching cost, Calaveras Dam (Herrmann)			4983	1338
			5155	1389
Trenching cost, Dry Canyon Dam, Los Angeles Aqueduct (Herrmann)			4981	1337
Trenching cost, lagging at Pilarcitos and San Andres (Dillman)	5156	1389		
Trenching cost, Los Angeles Aqueduct (Herrmann)			5155	1389
Trenching cost, Modesto Irrigation Dist. (Herrmann)			4982	1338
Trenching cost, Modesto District (Herrmann)			5155	1389
Trenching cost, North Haiwee Dam, Los Angeles Aqueduct (Herrmann)			4982	1338

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Trenching, detail of cost (Dockweiler)	5049	1357		
Trenching, detail of operations (Dockweiler)	5049	1357		
Trenching, Dillman did not consider lagging in his estimate	5021	1349		
Trenching, Dockweiler estimated on a standard Spring Valley trench taken from the plans	5048	1357		
Trenching, Dockweiler figured 9 hr. day-labor at $2.50	5048	1357		
Trenching, Hazen considered lagging in his estimates			5022	1350
Trenching, Herrmann considered lagging in his estimate			5023	1350
Trenching, labor costs (Dockweiler)	5050	1358		
Trenching, lagging not included in original estimate (Dillman)	5168	1393		
Trenching, Pilarcitos Dam, unit cost (Hazen)			4951	1325
Trenching, Pilarcitos Dam, very expensive (Hazen)			4951–4952	1325–1326
Trenching, quantities and material used in estimate of Calaveras Dam (Herrmann)			4980	1337
Trenching, unit costs (Dillman)	5021	1349		
(Dockweiler)	5053	1359		
Trenching, unit costs on San Andres (Dillman)	5027	1351		
Trenching, voids in material handled by steam shovel, San Fernando Dam, Los Angeles (Elliott)			5391	1455
Twin Lakes, cost of embankments (Ellis)	5254	1419		
Vallejo Dam, Dockweiler familiar with	5029	1352		
Vallejo Dam is just as good as San Leandro Dam (Dillman)	5181	1396		
Vallejo Dam was built with puddle (Dillman)	5181	1396		
Wages for labor assumed at Pilarcitos (Ellis)	5233	1413		
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Wild Horse Dam No. 2 (Vallejo, Cal.) borrow pits description of (Noyes)	5274	1425		
Wild Horse Dam No. 2 (Vallejo, Cal.) built by Lewis Moring (Noyes)	5261	1421		
Wild Horse Dam No. 2 (Vallejo, Cal.) built when construction was cheap (Noyes)	5285	1427		
Wild Horse Dam No. 2 (Vallejo, Cal.) brush, character of (Noyes)	5269	1424		
Wild Horse Dam No. 2, Clearing cost (Noyes)	5269	1424		
Wild Horse Dam No. 2, contract price (Noyes)	5267	1423		
Wild Horse Dam No. 2, contractor owned his own stock (Noyes)	5285	1427		
Wild Horse Dam No. 2, contractor's profit on	5267	1423		
Wild Horse Dam No. 2, cost accounts verified by contractor	5266	1423		

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Wild Horse Dam No. 2, dimensions of (Noyes)..	5261	1421		
Wild Horse Dam No. 2, embankment (Noyes)....	5268	1424		
Wild Horse Dam No. 2, excavation cost (Noyes).	5269	1424		
Wild Horse Dam No. 2, extract from specifications for (Noyes)	5263–5265	1422–1423		
.....	5270	1425		
Wild Horse Dam No. 2, had no core wall (Noyes)	5261	1421		
Wild Horse Dam No. 2, labor, cost of 10 hr. (Noyes)	5271	1425		
Wild Horse Dam No. 2, length of haul from borrow pits (Noyes).....	5270	1424		
Wild Horse Dam No. 2, material, character of (Noyes)	5262	1422		
Wild Horse Dam No. 2, method of construction (Noyes)	5262	1422		
Wild Horse Dam No. 2, rip-rap cost (Noyes)....	5273	1425		
Wild Horse Dam No. 2, settled 14" (Noyes).....	5265	1423		
Wild Horse Dam No. 2, terms of contract (Noyes)	5268	1424		
Wild Horse Dam No. 2, total cost (Noyes).....	5267	1423		
Wild Horse Dam No. 2, total yardage (Noyes)..	5261	1421		
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General remarks (Hazen)			5410	1459
DAMS, POWER				
Overhead and indirect expenses on (Lippincott)..			5493	1489
DEPRECIATION				
Crystal Springs Upper Dam, 60% (Hazen).....			4955	1327
.....			5075	1366
Crystal Springs Upper Dam (Dillman).....	5075	1366		
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Brickwork, extract from "Engineering News" (Hazen)			5453	1476
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Dillman would use a derrick in trench construction at Pilarcitos.....	5173	1394		
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Direct examination (Dams).....	5011	1346		
.....	5017	1348		
.....	5022	1349		
.....	5028	1351		
.....	5157	1390		
.....	5288	1428		
.....	5687	1537		
.....	5724	1550		

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DILLMAN, GEO. L.—Continued.				
Cross-examination (Dams)	5158	1390		
	5180	1396		
	5289	1428		
	5296	1430		
	5915	1601		
	5949	1610		
Re-direct examination (Dams)	5181	1396		
Re-cross examination (Dams)	5182	1397		
Direct examination (Riveted pipe)	4255	1127		
	4261	1129		
	4411	1178		
	4431	1184		
	4481	1197		
	4487	1199		
	4729	1266		
	4734	1267		
Cros-examination (Riveted pipe)	4262	1129		
	4274	1132		
	4686	1255		
	4712	1263		
	4942	1322		
	4944	1322		
Re-direct examination (Riveted pipe)	4713	1263		
	4715	1264		
	4858	1301		
Direct examination (Submerged pipe)	4825–4826	1291		
Cross-examination (Submerged pipe)	4850	1299		
	4858	1301		
	4999	1343		
	5010	1346		
Alameda Pipe Line, Ravenswood to Belmont, unit prices	4426	1183		
Alameda Pipe Line, unit prices	4425–4426	1182–1183		
Backfill, a man would throw not less than 10 yds. in 8 hours	5350			
Benching, description of	5025	1350		
Boilermakers' standard not used	4697	1258		
Caulking inside more important than outside	4714	1263		
Clearing earth dams, unit costs	5013	1347		
Coating, life of pipe depends on	4414	1179		
Core wall would settle with embankment	5177	1395		
Costs, earth dams, detail estimate	5012	1347		
Costs 5c per yd. more to handle material with steam shovel than with New Era Grader	5288–5291	1428–1429		
	5294			
Earth dams, never built any high ones	5011	1346		
Earth dams, unit costs of	5013	1347		
Embankment, railroad, percentage of settlement in	5165	1392		

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DILLMAN, GEO. L.—Continued.				
Experience with bids	4481–4492	1197–1198		
Formula, cost of submerged pipe	4851	1299		
Formula, Hazen's weight would not apply to light pipe	4853	1300		
Grubbing very heavy in trench excavation, Bull Run pipe line, Portland, Ore.	4508	1206		
Joints, Crystal Springs Dam, discussion of	5438	1471		
Joints, saw none in Crystal Springs Dam	5437	1470		
Lagging trench not included in original estimate.	5168	1393		
Life and condition of Spring Valley pipe due to coating	4415	1179		
Meters, cost of on Haywards job	4482	1198		
New Era Grader, capacity of	5288	1428		
New Era Grader, cost of operating	5292	1429		
New Era Grader could be used in borrow pits below Pilarcitos and San Andres Dams	5281	1427		
New Era Grader could be used on boulders	5283	1427		
New Era Grader could not be used at Pilarcitos or San Andres	5280			
New Era Grader, efficiency of	5292	1429		
New Era Grader, knows of several small dams where used	5278	1426		
New Era Grader, less expensive method	5282	1427		
New Era Grader used on Oakdale Irrigation Dist.	5278	1426		
Overhead included in total cost, San Andres Line	4380	1169		
Pilarcitos, spent less than 10 hrs. in examination of	5169	1393		
Pilarcitos Dam, type of structure estimated on	5175	1395		
Pipe line built by, for Contra Costa Water Co., was fabricated by Risdon Iron Works	4686	1255		
Pipe line built for Contra Costa Water Co., not less than 16"	4686	1255		
Pipe manufacture, never had any experience in	4700	1259		
Pipe, riveted, did not get any quotations on	4688	1256		
Pipe, riveted, table explained	4417	1181		
Pipe, riveted, table showing weight and cost per lineal foot	4416	1180		
Pipe, wrought iron, had no experience in	4690	1256		
Pipe, wrought iron, never laid any	4413	1179		
Point of view in appraisal of Spring Valley properties	4411–4412	1178		
	4413	1179		
Puddle core and embankments, percentage of settlement in	5164	1392		
Qualifications	4255	1127		
	4274	1132		
Quotations from manufactures are invariably cut in the bids	4482	1198		
Ravenswood line, basis of estimates on	4849–4850	1299		

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DILLMAN, GEO. L.—Continued.				
Rollers, grooved, not considered necessary on embankment work	5014	1348		
San Andres 44" pipe line, unit prices	4384	1169		
San Andres line, total cost includes overhead	4380	1169		
San Mateo Dam No. 1, detailed estimate	5028	1351		
Shrinkage of material in embankments	5160	1391		
Steam shovel, capacity of	5288–5289	1428		
	5294–5295	1429		
Steam shovel, capacity of, for embankment work	5014	1348		
Steam shovel, cost of operating	5292	1429		
Steam shovel, will handle more material than New Era Grader	5291	1429		
Submerged pipe, did not go into details in his appraisal of	4825	1291		
Submerged pipe, never laid any	4850	1299		
Submerged pipe, total estimate	4759	1272		
Submerged pipe, value of	4826	1291		
Tamping backfill, one man tamping, two men throwing into ditch	5351			
Trenching, estimate on did not include lagging	5021	1349		
Trenching, Pilarcitos, assumed no hard rock	5173	1394		
Wrought iron has no advantage over steel as long as coating is intact	4415	1179		
Wrought iron is worked easier for punching and caulking	4413	1179		
DILLMAN'S FORMULA				
His information on 24" pipe line at Portland, Ore., does not check his formula on cost of submerged pipe	5006	1345		
DIPPING				
Baker Iron Works' letter, prices include (Dockweiler)	4638	1243		
Cost of agreed to by Dockweiler and Hazen			4342	1155
Los Angeles syphon pipe not dipped, but painted (Hazen)			4555	1218
Riveted pipe, labor costs (Lawrence)			5323–5324	1436
Riveted pipe, quotations from Carey's testimony in 1904 case (Lawrence)			5323	1436
San Andres 30" line, cost of (Lawrence)			4398	1174
Spring Valley pipe, very good (Hazen)			4342	1155
DIPPERS				
Steam shovel at Pilarcitos, you would get one and a fraction swings per minute for a yard and a half dipper (Dockweiler)	5208	1404		
Steam shovel, Dockweiler has frequently seen two dipper loads per minute	5209	1404		
Steam shovel, Dockweiler says you might get 3 or 4 swings a minute with dipper	5207	1404		

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DISTRIBUTION SYSTEM				
Excavation, cost of, including backfill, 75c per cu. yd. (Hazen)			4356	1161
Excavation, 10% added for accessories and contingencies to excavation cost (Hazen)			4356	1161
DOCKWEILER, J. H.				
Direct examination (Dams)	5029	1352		
.....	5055	1361		
.....	5056	1361		
.....	5081	1367		
.....	5725	1550		
.....	5771	1561		
.....	5785	1565		
Cross-examination (Dams)	5186	1398		
.....	5210	1404		
Re-direct examination (Dams)	5211	1404		
Direct examination (Riveted pipe)	4193	1110		
.....	4199	1113		
.....	4432	1184		
.....	4478	1197		
.....	4584	1229		
.....	4586	1229		
.....	4800	1285		
.....	4824	1291		
Cross-examination (Riveted pipe)	4199	1113		
.....	4252	1126		
.....	4590	1129		
.....	4666	1250		
.....	4859	1301		
.....	4880	1306		
Re-direct examination (Riveted pipe)	4253	1126		
.....	4667	1250		
.....	4686	1255		
.....	4726	1266		
.....	4728	1266		
.....	4773	1277		
.....	4798	1284		
Re-cross examination (Riveted pipe)	4253–4254	1126		
Alameda 54" line, price $9.61 per foot dipped (Dockweiler)	4668	1251		
Assumed that fabrication of pipe would be done by contract (Dockweiler)	4432	1184		
Baker Iron Works' figures higher than Lacy Bros.	4622	1239		
Baker Iron Works' prices on pipe include dipping	4638	1243		
Barge and tub boat service for laying submerged pipe, cost of	4781	1279		
Benching old Pilarcitos Dam, makes no allowance for	5059	1361		

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DOCKWEILER, J. H.—Continued.				
Bends, cost of	4656	1248		
Bevelling not done unless specified on pipe fabrication	4610	1235		
Bevelling would require it in specifications for riveted pipe	4610	1235		
Bids for 30″ 5/16″ pipe for Los Angeles	4454	1191		
Bids, Lacy Bros. on riveted pipe	4798	1284		
Bids, Llewellyn Iron Works on San Diego riveted pipe	4798	1284		
Bids, obtained from minutes of Spring Valley Co.	4656	1248		
Bids, received by Sacramento for riveted steel and cast-iron pipe	4473–4475	1196–1197		
Bids, record of submitted to San Diego	4671	1251		
Blasting, method used at San Fernando in steam shovel pit	5198	1401		
Borrow-pits, location of for Pilarcitos Dam	5054	1360		
Borrow-pits, Pilarcitos, information as to location furnished by Ebright, keeper	5399	1458		
Cartage and freight, riveted iron	4656	1248		
Caulkers, wages of	4645	1245		
Caulking, cost of	4644	1245		
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Can sell pipe cheaper than other companies (Hazen)			4549	1217
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Borden Brook Dam, contract price for, Springfield, Mass. (Hazen)			4946	1323
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Dockweiler's detailed, cost of laying submerged pipe	4784	1281		
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Dockweiler's, on steam shovel work would take care of lay-offs at Pilarcitos	5041	1356		
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Dockweiler's total on 22" submerged pipe	4791	1282		
Dorward explains his on Spring Valley riveted pipe	4906–4907	1313		
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Excavation, Hazen's estimate of 75c per yard was based on his experience in trench work			4563	1221
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Hazen's estimate comports with Metcalf's views (Metcalf)			4580–4581	1227–1228
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Joints, value of (Dockweiler)	4781	1279		
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Made on Sacramento water supply for San Francisco (Hazen)			4489	1200
Materials, submerged pipe, Dockweiler's estimate	4875	1304		
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Of time were based on progress profile (Dockweiler)	4789	1282		
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Pleasanton Line detail of estimated price (Dockweiler)	4604	1234		
Pilarcitos Dam, type of structure Dillman estimated on for	5475	1395		
Pilarcitos Dam was not important for Dillman's estimate to know depth of trench	5166	1392		
Puddling, estimated cost on Crystal Springs Dam (Lippincott)			5486	1486
Puddling, Modesto Irrigation District, detail of (Herrmann)			4984	1339
Records of work in steel cannot be used without modifications in estimates for wrought iron			4351	1159
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Steam shovel work, Calaveras Dam			5384	1453
Steam shovel work, quantities assumed in estimating (Dockweiler)	5038	1355		
Submerged pipe, Dockweiler's estimates compared to actual cost for 16"	4866	1303		
Submerged pipe, values (Dillman)	4861	1301		
(Dockweiler)	4878	1305		
Timbering, Sunol Filter Galleries, not included in (Hazen)			5457	1477
Trenching, Dillmann did not consider lagging (Dillman)	5021	1349		
Trenching, Hazen considered lagging at Howard Cut			5022	1350
Trenching, Herrmann allowed for lagging at Howard Cut			5023	1350
EUROPEAN WAR				
Cost of fabrication and wages in re steel pipe have not dropped since beginning of (Dockweiler)	4675	1252		
Price of steel has been low since (Dockweiler)	4675	1252		
EXAMINATIONS				
By Ellis, of Spring Valley Water Co. excavations	4886	1308		
Pilarcitos spent less than 10 hours in examination at	5169	1393		
Pipe, Dillman examined, taken up at San Bruno and Millbrae	4695	1258		
Ravenswood pipe (Dillman)	4853	1299		
EXCAVATION				
Alameda Pipe Line 1898, contractor went broke (Lawrence)			5333	1438
Alameda Pipe Line, quotations from minute book "D"			5333	1438
Argonaut Pipe Line, cost 38.4c a yard (Ellis)	4886	1308		
Average cost estimated at 70c cubic yard including backfill and excluding paving replacement (Ellis)	4886	1308		
Bull Run Pipe Line, grubbing very heavy (Dillman)	4508	1206		
Bull Run Pipe Line, Portland, Ore., figures from (Dockweiler)	4457	1192		

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EXCAVATION—Continued.				
Bull Run Pipe Line, Portland, Ore., grubbing was not included in cost of excavation (Hazen)			4507–4508	1206
Comparison of cost per foot at Portland, Ore., with Spring Valley (Hazen)			4506	1205
Correction in testimony Hazen cost Portland, Ore., pipe line 1894			4393	1172
Cost, estimate based on handwork (Ellis)	4888	1308		
Cost of, Alameda pipe line 1888 (Hazen)			4390	1171
Cost of, Alameda pipe line 54" (Hazen)			4391	1171
Cost of, elimination of State Highway makes figures 65c instead of 70c (Ellis)	4888	1309		
Cost of, for riveted pipe line (Hazen)			4389–4390	1170–1171
Cost of, on first Bull Run pipe line, Portland, Ore., 1894, compartively low, 2nd 17 years later much greater (Hazen)			4509	1206
Cost of, ordinary, assumed at 50c a cubic yard (Dillman)	4417	1181		
Cost of, per cubic yard for riveted pipe lines (Hazen)			4388	1170
Cost of, Portland, Ore., 1894 (Hazen)			4392	1172
Cost of, Portland, Ore., 1911 (Hazen)			4392	1172
Cost of, puddle excavation South Haiwee Dam, Los Angeles Aqueduct (Herrmann)			5116	1377
Cost of, used records of Seattle, Portland and Victoria (Hazen)			4564	1222
Cost of, would be about the same as in the East (Hazen)			4563	1221
Crocker Tract cost of 15½c cubic yard, backfill 3.2c (Ellis)	4887	1308		
Crystal Springs Dam, cost of excavating for tower (Lippincott)			5534	1501
Crystal Springs Dam, quantities and unit costs (Hazen)			5408	1459
Crystal Springs Line cost 50c per cubic yard (Dillman)	4423	1182		
Details of yardage for different sized pipe in Spring Valley (Hazen)			4506–4507	1205–1206
Different character of excavation makes little difference in cost on Spring Valley pipe lines (Hazen)			4383	
Dillman assumed that he would not encounter any hard rock in the trenches at Pilarcitos Dam	5173	1394		
Distribution system, cost includes backfill 75c per cubic yard			4356	1161
Elizabeth Tunnel, cost of (Lippincott)			5534	1500
Estimated cost of for flumes (Hazen)			5221	1408
Flumes, cost is Hazen's own estimate			5216	1406

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EXCAVATION—Continued.				
Flumes, cost of (Hazen)			5455	1476
Flumes, estimated cost of (Hazen)			5215	1406
(Herrmann)			5373	1449
Flumes, method of estimating cost of (Hazen)			5214	1406
Flumes, more difficult than road excavation (Hazen)			5221	1408
Flumes, unit cost of (Lawrence)			5377	1450
Glue Factory to San Leandro pipe line, cost considerably less than 50c cubic yard (Dillman)	4418	1181		
Hazen's estimate of 75c per yard was based on experience in trench work			4563	1221
Hazen familiar with trenching on Bull Run pipe line, Portland, Ore.			4507	1206
Is easier at Sacramento than in and around San Francisco (Hazen)			4574	1225
Los Angeles, cost of 40" line (Dockweiler)	4459–4461	1192		
Los Angeles, cost of on 5/16" line (Dockweiler)	4462	1193		
Method used in flumes (Hazen)			5220	1407
Pleasanton pipe line (Lawrence)			5341	1440
(Hazen)			5342	1440
Riveted pipe, cost of labor for (Lawrence)			5332	1438
Riveted pipe, extracts from Hazen's testimony			5343	1440
Riveted pipe, Lawrence had no experience with trenching machines			5312	1434
Riveted pipe, Lawrence considered work would be done by same method in 1913 as when Spring Valley pipe was laid			5312	1433
Riveted pipe, livery hire item (Lawrence)			5345	1441
Riveted pipe, outside of city, total quantity (Hazen)			4355	1161
San Andres 44" line (Dockweiler)	4436	1185		
San Andres 44" line, description of excavation work (Lawrence)			5334	1438
San Andres 44" line total cost $28,313.38 (Dockweiler)	4437	1186		
Spring Valley Water Co. excavation by Ellis	4886	1308		
Spring Valley system cost 70c a cubic yard (Ellis)	4886	1308		
Stanislaus Co. Dillman let contract at 26c cubic yard	4418	1181		
Stanislaus Co. work cheaper than Spring Valley (Dillman)	4687	1255		
Stanislaus Co. work done by trenching machine (Dillman)	4687	1255		
Sutter Creek syphon, cost of (Ellis)	4887	1308		
Trenches, Ellis has not excavated in any roads	4994	1341		
Trenches, wide more expensive than narrow (Ellis)	4995	1341		

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EXCAVATION—Continued.				
Trenching, unit prices for, in State Highway (Ellis)	4997	1342		
Unit prices of Ellis compared to Hazen's	4998	1342		
Wild Horse Dam No. 2, cost of (Noyes)	5269	1424		
Yardage shown in "P 37", Lawrence analysis was obtained from profiles (Lawrence)			4406	1177
EXHIBITS				
50 Plaintiff. Identified California laurel tree, west side State Highway near bridge over San Francisquito Creek			4281	1135
51 Plaintiff. Identified, Knoll in front F. W. Sharon residence, which lies westerly from Menlo Park			4281	1135
52 Plaintiff. Identified, U. Porter property, back of Los Altos			4281	1135
53 Plaintiff. Identified John Oertlis land back of Los Altos			4281	1135
54 Plaintiff. Identified, knoll in front of Sharon place, facing residence			4281	1135
55 Plaintiff. Identified, top of knoll property of Dr. Shumate, back of Los Altos			4281	1135
56 Plaintiff. Identified, opposite H. D. Morton property at Los Altos			4281	1135
57 Plaintiff. Identified, knoll east of Percy Morgan place at Los Altos			4281	1135
58 Plaintiff. Identified, on Purissima Ave. back of Los Altos			4281	1135
59 Plaintiff. Identified, property of Morsehead, opposite Portola store			4281	1135
60 Plaintiff. Identified, property belonging to estate F. G. Sanborn at Los Altos			4281	1135
61 Plaintiff. Identified, northwest of the Hill place, and near Prof. Sloan's place at Los Altos			4281	1135
62 Plaintiff. Identified, Morton place at Los Altos			4282	1135
63 Plaintiff. Identified, knoll south of C. A. Graves residence at Los Altos			4282	1135
64 Plaintiff. Identified, property of Leland Stanford University, back of the professors' houses			4282	1135
65 Plaintiff. Identified, knoll on the Burke property, back of Los Altos			4282	1135
66 Plaintiff. Identified, knoll east of Percy Morgan, place at Los Altos			4282	1135
67 Plaintiff. Identified, taken from Pulgas Ave. to the west of Menlo Park			4282	1135
68 Plaintiff. Identified, back of Los Gatos, east of property of California Chicken Co.			4282	1135

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	Record	Abstract	Record	Abstract
EXHIBITS—Continued.				
69 Plaintiff. Identified, taken of Las Pulgas Ave. near property of Alex. Hamilton.....			4282	1135
70 Plaintiff. Identified, Kohl property at Easton			4282	1135
71 Plaintiff. Identified, Kohl property at Easton			4282	1135
72 Plaintiff. Identified, east from Apperson Ave. in Menlo Heights.....			4282	1136
73 Plaintiff. Identified, southern end of Upper Crystal Springs Lake.....			4282	1136
95 Defendants. Metcalf pamphlet entitled "Twelve Years of Professional Work" issued by Metcalf & Eddy (Searls).....	4254	1126		
96 Plaintiff. Detailed reproduction cost, estimate of structural property of the Spring Valley Water Co. as of December 31, 1913 (Hazen)			4296	1140
97 Plaintiff. Summarized reproduction cost, estimate of the property of the Spring Valley Water Co. as of December 31, 1913 (Hazen)...			4296	1140
98 Plaintiff. Riveted pipe, arranged by sizes..			4324	1149
98a Plaintiff. Schedule of main lines of riveted pipe, arranged chronologically.....			4324	1149
98b Plaintiff. Summary of plates in main lines of entire system, arranged by sources from which metal was obtained.....			4324	1149
98c Plaintiff. Main lines of relaid pipe and steel pipe			4324	1149
98d Plaintiff. Main line of riveted conduit in system, that is to say, pipe made by less than standard riveting and without caulked joints....			4324	1149
98e Plaintiff. Prices and quotations, charcoal iron			4327	1149
98f Plaintiff. Prices and quotations for puddled iron			4329	1150
98g Plaintiff. Annual average prices for steel plate			4329	1150
98h Plaintiff. Fluctuation in market prices at Pittsburg of Bessemer pig-iron and steel tank plates			4330	1150
98i Plaintiff. Estimated cost per pound of complete wrought iron and steel pipe, as used by Allen Hazen in original estimate.....			4357	
98j Plaintiff. Cost of manufacturing riveted pipe			4357	1161
98k Plaintiff. Estimated cost of wrought iron pipe, etc.			4370	1166
98l Plaintiff. Summary main lines of riveted pipe			4372	1167

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EXHIBITS—Continued.				
98m Plaintiff. Memorandum of auxiliary structures, etc.			4361	
98n, 98o, 98p, 98q } Hazen data on submerged pipe			4772	1277
98r Plaintiff. Hazen data Upper Crystal Springs Dam			5092	1370
98s Plaintiff. Hazen data on flumes			5112	1405
99 Plaintiff. Analysis of data upon original cost under original conditions, but present prices of riveted pipe by W. B. Lawrence, Oct. 1, 1915			4410	1178
100 Defendant. Cost of riveted wrought iron pipe delivered at trench undipped, country, J. H. Dockweiler	4469	1195		
100a Defendant. Cost of riveted wrought iron pipe delivered at trench undipped, city, Dockweiler	4469	1195		
100b Defendant. Cost of riveted wrought iron pipe per foot riveted joints, country, J. H. Dockweiler	4469	1195		
100c Defendant. Riveted wrought iron pipe, Western Pipe & Steel Co., J. H. Dockweiler	4469	1195		
100d Defendant. Estimated cost Schaw-Batcher Pipe Works, J. H. Dockweiler	4470	1195		
100e Defendant. Bids, pipe lines, minutes of Spring Valley Water Co.'s books, J. H. Dockweiler	4472	1196		
100f Defendant. Copy of Lacy Mfg. Co. bids, J. H. Dockweiler	4473	1196		
100g Defendant. Schaw-Ingraham-Batcher letter, J. H. Dockweiler	4661	1249		
100h Defendant. Letter from Baker Iron Wks. addressed to J. H. Dockweiler	4670	1251		
100i Defendant. Record of prices of riveted steel pipe, Los Angeles City Water Dept., J. H. Dockweiler	4672	1152		
100j Defendant. Showing the additional cost units on riveted pipe used by J. H. Dockweiler	4727	1266		
100k Defendant. Schedule of bids on 24" steel pipe line, San Diego, J. H. Dockweiler	4797	1284		
100l Defendant. Tabulation on bids city of City of Sacramento, Dockweiler	4798	1284		
100m Defendant. Arthur L. Adams figures 24" riveted pipe, Robert M. Searls	4798	1284		
101 Defendant. Inventory and appraisal of structural properties outside City and County of San Francisco, Geo. L. Dillman	4730	1266		

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EXHIBITS—Continued.	Record	Abstract	Record	Abstract
102 Defendant. Rhodes data on pipe manufactured by Montague & Co. for Monterey Water Works	4747	1269		
103 Defendant. Dorward's estimate	4916	1315		
104 Defendant. Dorward's estimate, cost of reproduction	4921	1317		
105 Plaintiff. F. C. Herrmann's appraisal			4962	1330
106, 106a, 106b Defendant. A. P. Noyes tabulations in re Wild Horse Dam No. 2, Vallejo	5267	1423		
107 Defendant. Computation and excavation on backfill	5342	1440		
108 Plaintiff. Herrmann data on flumes			5362	1445
109 Plaintiff. W. B. Lawrence; flumes			5376	1450
Explanation of Ex. 109			5376	1450
110 Plaintiff. Photographs taken by Mr. Elliott showing San Fernando and Lower Franklin Dams, Los Angeles			5393	1455
111 Plaintiff. Allan Hazen memoranda, regarding concrete, brickwork and excavation, including Crystal Springs Dam			5408	1459
112 Plaintiff. J. B. Lippincott's memo. of construction data			5481	1484
Explanation of sheet 24			5515	1495
EXPENDITURES				
Required to bring plant up to present need (Hazen)			4280–4284	1134–1136
EXPENSES				
Indirect, Gibraltar Dam, Santa Barbara (Lippincott)			5493	1489
Los Angeles Aqueduct, auxiliary expense (Hazen)			4559	1220
Overhead and indirect expenses on power dams (Lippincott)			5493	1489
EXPENSES, ENGINEERING				
Crystal Springs Dam, allowance for (Lippincott)			5504	1492
EXPENSES, INDIRECT				
Power dam (Lippincott)			5493	1489
EXPERIENCE				
Dillman had none in wrought iron pipe	4690	1256		
Dillman saw construction of last portion of San Leandro Dam	5011	1346		
Dockweiler familiar with Central Reservoir Dam, Oakland, Cal.	5030	1352		
Dockweiler familiar with costs Los Angeles Aqueduct	5029	1352		
Dockweiler familiar with dams of Pacific Gas & Electric Co.	5030	1352		
Dockweiler familiar with San Leandro Dam	5029	1352		

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EXPERIENCE—Continued.				
Dockweiler familiar with Schussler's testimony..	5029	1352		
Dockweiler familiar with Vallejo Dam.....	5029	1352		
Dockweiler has never seen any submerged pipe laid	4860	1301		
Dockweiler has read literature on subject of earthen dams	5030	1352		
Dockweiler laid 1200 feet submarine outfall sewer pipe in Los Angeles.....	4858	1301		
Dockweiler studied history of Spring Valley dams	5029	1352		
Earth dams, Dillman never built any high ones..	5011	1346		
Hauling for flumes based on Calaveras experience (Herrmann)			5368	1447
Hazen's experience with riveted pipe.....			4375–4376	1168
Hazen has built and designed earth dams similar to Pilarcitos and San Andres.....			4945	1322
Hazen has had no experience in pipe works in San Francisco			4493	1201
Lawrence has had no experience with trenching machines			5312	1434
Pipe manufacture, Dillman never did any.....	4700	1254		
Submerged pipe, Dillman has not had much.....	4856	1300		
EXPLORATION				
Earth Dams cost, not included in unit costs (Herrmann)			4993	
Earth dams, cost will be carried by the figures (Metcalf)			4993	
Of Pilarcitos Dam not shown in inventory (Greene)			4992	1341
Not included in estimate on Pilarcitos Dam.....			5117	1378
FABRICATION				
Basis of assumption that wrought iron would cost less than steel (Dillman).....	4699	1259		
Basis of fabrication cost riveted pipe (Hazen)...			4492	1201
Contra Costa Water Co. line built by Dillman, fabricated by Risdon Iron Works.....	4686	1255		
Contra Costa Water Co. pipe line built by Dillman, does not know cost of.....	4687	1255		
Cost and wages in re steel pipe have not dropped since beginning of European war (Dockweiler)	4675	1252		
Cost from F. Hewson for 24" pipe (Dockweiler).	4630	1241		
Cost of, from various people (Dockweiler).....	4630	1241		
Cost of, in Los Angeles higher than in the East on riveted pipe (Hazen).....			4516	1208
Cost of, in San Francisco 20% greater than in East on riveted pipe (Hazen).....			4493	1201
Cost of, on Pine Canyon line could not be segregated for different thicknesses of steel (Hazen)			4553	1218
Cost of syphon, for Los Angeles Aqueduct (Hazen)			4551	1217

FABRICATION—Continued.	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
Cost per lb. for shop work and work in trench for straight pipe (Hazen)			4538	1213
Dorward was familiar with the Spring Valley specifications	4895	1310		
Eastern pipe can be manufactured from 10 to 12% cheaper than here (Dorward)	4922	1317		
Foreign and cheap labor is not used in fabricating pipe in Eastern pipe works (Hazen)			4993	1201
Great deal of pipe fabricated in Los Angeles would not stand test and inspection of Eastern works (Hazen)			4516	1208
Hazen's estimate based on what it costs Spring Valley to make pipe without any corrections			4539	1214
Hazen explains reason for adding 9.4% to Eastern prices for Spring Valley cost			4533	1213
Improved method of, would lessen cost (Rhodes)	4755	1271		
Increase of 20% added to riveted pipe of Spring Valley if done in San Francisco (Hazen)			4514	1208
Inspectors usually leave out important items in keeping shop costs (Hazen)			4762	1273
Lacy Bros. assumed to be within 60 miles of San Francisco (Dockweiler)	4626	1240		
Los Angeles pipe in schedule furnished by Mulholland, fabricated under specifications (Dockweiler)	4685	1254		
Method of, has improved (Rhodes)	4754–4755	1271		
Monterey Water Works, got costs from (Dockweiler)	4630	1241		
Not as efficiently done in East on account of the cold (Dockweiler)	4623	1239		
Park line pipe fabricated in San Francisco (Hazen)			4523	1210
Pipe, labor cost .6 of a cent per pound (Dockweiler)	4648	1247		
Pipe riveted, cost of (Moebus)	4935	1320		
Pipe riveted, finicky inspection (Dockweiler)	4599	1232		
Pipe riveted, generally made to order (Dockweiler)	4590	1229		
Pipe riveted, inspection would not make additional expense (Dockweiler)	4599	1232		
Pipe riveted, inspector should be on job all time (Dockweiler)	4596	1232		
Pipe riveted, letter from Lacy Bros. in re (Dockweiler)	4443	1187		
	4447	1189		
Pipe riveted, should be reasonable inspection (Dockweiler)	4596	1232		
Pipe riveted, specifications for largest line used by Spring Valley (Dockweiler)	4591	1229		

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FABRICATION—Continued.				
Pipe riveted, specifications should require proper inspection (Dockweiler)	4596	1232		
Pleasanton line not up to Spring Valley standard (Dockweiler)	4603	1234		
Price of labor does not control manufacture of riveted pipe (Hazen)			4518	1209
Profit on riveted pipe would run from 15 to 25% between 1907 and 1912 (Moebus)	4934	1320		
Quotations from Western Pipe & Steel Co. in re (Dockweiler)	4449	1190		
Risdon Iron Works, methods used (Dorward)	4907	1313		
	4923–4925	1317–1318		
Risdon Iron Works, no pipe could be made better than pipe made by, for Spring Valley (Dorward)	4922–4925	1317–1318		
Riveted pipe costs more if done under proper specifications and supervision (Hazen)			4569	1224
Riveted pipe made by Risdon Iron Works, very good (Hazen)			4525	1210
Riveted pipe quotations not to be depended on (Hazen)			4569	1224
Riveted pipe. See also Pipe Riveted				
Schussler said Francis Smith Co.s' work was good (Moebus)	4941	1321		
Shop costs, how obtained (Hazen)			4763	1273
Shop costs of making riveted pipe about same in 1900 as in 1912 (Moebus)	4934	1320		
Shop labor, don't remember any man saying it cost 6/10 of cent (Dockweiler)	4634	1242		
Smith Co.'s, Francis, cost of making Spring Valley 36" pipe (Moebus)	4934	1320		
Smith Co.s', Francis, shop overhead on riveted pipe 10% (Moebus)	4934	1320		
Spring Valley paid good price for pipe made by Risdon Iron Works (Dorward)	4925	1318		
Spring Valley pipe made by Risdon Iron Works table by Dorward showing cost (Dorward)	4891–4899	1309–1311		
The increase in cost of making riveted pipe would not have been very much between 1907 and 1912 (Moebus)	4934	1320		
Victoria, B. C., plates were fabricated in Canada (Hazen)			4512	1207
Victoria, B. C., Scotch plates scarcely comparable to Spring Valley plates (Hazen)			4513	1207
FILLS				
Calaveras Dam, cost of (Hazen)			5110	1375
Cost of puddle fill, Dry Canyon Dam (Dockweiler)	5199	1402		

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FILLS—Continued.				
Dallas-Warner, method used in building fill, Modesto District (Herrmann)			5141	1384
FLUMES				
Caulking and tarring, estimated cost of (Herrmann)			5372	1449
Caulking Sierra flumes, are not ordinarily caulked (Herrmann)			5372	1449
Construction, method used by Spring Valley Water Co. (Lawrence)			5375	1450
Cost, detail of (Herrmann)			5368	1447
Cost, Hazen used Lawrence's figures in his estimate			5213	1405
Cost, items included in estimate (Herrmann)			5367	1447
Cost, method of figuring (Hazen)			5213	1405
Economical method of transporting water (Hazen)			5219	1407
Excavation, cost of (Hazen)			5455	1476
Excavation costs, were Hazen's own estimates			5216	1406
Excavation, estimated cost (Hazen)			5215–5221	1406–1408
(Herrmann)			5373	1449
Excavation, method of estimating cost (Hazen)			5214	1406
Excavation, methods used (Hazen)			5220	1407
Excavation, more difficult than road excavation (Hazen)			5221	1408
Excavation, unit costs (Lawrence)			5377	1450
Explanation of certain items (Hazen)			5217	1407
Hauling, based on Calaveras experience (Herrmann)			5368	1447
Hauling, cost of at Calaveras (Herrmann)			5368	1447
Hauling, cost of operating a truck (Herrmann)			5368	1447
Hauling, cost per ton mile (Herrmann)			5369	1448
Hauling, estimated cost at San Andres (Herrmann)			5369	1448
Labor, Herrmann familiar with rules of steam shovel men			5373	1449
Last longer in West than in East (Hazen)			5220	1407
Los Gatos Canyon, cost of (Herrmann)			5365	1446
Lumber, cost of f.o.b. Millbrae (Herrmann)			5365	1446
Lumber, made no allowance for waste (Lawrence)			5370	1448
Lumber, price of (Dockweiler)	5366	1447		
Lumber, prices obtained from Lawrence (Hazen)			5216	1406
Lumber requirements and specifications (Lawrence)			5374	1449
Lumber, used in Spring Valley flumes was subjected to rigid inspection (Lawrence)			5375	1450
Lumber, waste figured at 5% (Herrmann)			5370	1448
Modesto Irrigation District flumes, cost of (Herrmann)			5362	1445

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FLUMES—Continued.				
New River flume, cost of (Herrmann)			5365	1446
Sierra flumes not comparable to Spring Valley flumes (Herrmann)			5372	1449
South San Joaquin Irrigation flumes, cost of (Herrmann)			5363	1446
Waste allowed for in inventory (Dockweiler)	5370	1448		
FOREMAN				
Wages of on riveted pipe work (Lawrence			5327	1436
			5336	1439
			5343	1440
FORMULA				
Cost, submerged pipe (Dillman)	4851	1299		
Dillman thinks formula wrong in re thin plates	4701–4706	1260		
Dillman would not apply to light pipes	4853	1300		
Explained by Dillman	4708	1261		
For computing weights of pipe (Hazen)			4333	1151
For computing weights of welded submerged pipe (Hazen)			4771–4772	1276–1277
For pipe weights explained (Hazen)			4708	1261
Hazen's formula on weights does not apply to Spring Valley pipes			4527–4528	1211
Hazen's formula represents weight of all ordinary steel pipe			4527	1211
If pipe weight checks, formula would be right (Dillman)	4708	1261		
Weights, Lawrence weights were used with some modification (Hazen)			4710	1262
FRAMES				
Part of concrete cost (Dillman)	5168	1393		
FRANKLIN CANYON DAM, LOS ANGELES				
Capacity of steam shovel at	5192	1400		
Details of haul at (Dockweiler)	5033	1353		
Dockweiler has records of steam shovel work on	5033	1353		
Letter from H. L. Jacques in re output of steam shovels (Dockweiler)	5034			
Materials used on (Dockweiler)	5191	1399		
Method of construction (Dockweiler)	5194	1400		
Record of steam shovel work on (Dockweiler)	5037	1354		
Was permanent work (Dockweiler)	5190	1399		
FRANKLIN DAMS, LOS ANGELES				
Hazen did not have cost of, at time of appraisal			5108	1374
Steam shovel conditions better than at Calaveras (Elliott)			5386	1453
Steam shovel work, conditions not comparable to Pilarcitos and San Andres Dams (Elliott)			5389–5390	1454
Visits to (Elliott)			5404	1458
FRANKLIN DAM LOWER, LOS ANGELES				
Steam shovel capacity (Elliott)			5384	1453

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FRANKLIN DAM UPPER				
Steam shovel delivery at (Elliott)			5384	1453
FREEMAN DAM SITE				
Calaveras stripping done in a rush (Harrmann)			5151	1388
FREIGHT				
And cartage on riveted pipe (Dockweiler)	4656	1248		
Lumber, Crystal Springs Dam, freight paid (Lippincott)			5478	1483
FREIGHT RATE				
From Pittsburg to Portland, Ore., 0.75c per lb. (Hazen)			4338	1153
On iron plates for pipe (Hazen)			4329	1150
Sheet "P 9" Lawrence analysis shows freight on finished pipe from San Francisco 1913			4400	1175
GALVANIZING				
Submerged pipe cost (Hazen)			4865	1302
Submerged pipe, Dockweiler's cost not segregated	4865	1302		
GAUGE				
Dillman used either the Birmingham or the U. S. gauge	4428	1183		
Pipe riveted, in buying, Dockweiler would specify gauge	4609	1235		
Pipe riveted safer and better way of buying (Dockweiler)	4608	1235		
Portland pipe bought to gauge (Hazen)			4528	1211
GAY, GEO. R. (CEMENT)				
Direct examination			5816–5821	1572–1574
Cross examination			5822–5826	1574–1575
GIBRALTAR DAM, SANTA BARBARA				
Cement, cost of (Lippincott)			5516	1495
Concrete, cost of mixing and placing (Lippincott)			5481	1484
Construction, method of (Lippincott)			5516	1495
Indirect expense (Lippincott)			5493	1489
Stripping, cost of (Lippincott)			5484	1485
			5532	1500
GOVERNMENT DAM				
Accounts, inactive (Lippincott)			5492	1489
Concrete, cost of (Lippincott)			5479	1483
			5529–5530	1499
Concrete, mix (Lippincott)			5528	1499
Concrete, mixing of (Lippincott)			5528–5530	1499
Stripping, cost of (Lippincott)			5484	1485
GRADERS, NEW ERA				
Can only be worked where soil is suitable (Noyes)	5277	1426		

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GRADERS, NEW ERA—Continued.				
Capacity of (Dillman)	5288	1428		
Capacity of compared to steam shovel (Noyes)	5293	1429		
Cost 5c per yard more to handle material with steam shovel (Dillman)	5288–5291	1428–1429		
	5294			
Cost of (Noyes)	5279	1426		
Could be used in borrow pits below Pilarcitos and San Andres Dams (Dillman)	5281	1427		
Could be used where there are boulders (Dillman)	5283	1427		
Description of (Noyes)	5274	1425		
Dillman knows of several small dams where used	5278	1426		
Efficiency of (Dillman)	5292	1429		
General discussion	5274–5284	1425–1427		
Less expensive than steam shovels (Dillman)	5282	1427		
Noyes never knew of use before construction of Wild Horse Dam No. 2 (Vallejo, Cal.)	5275	1426		
Operating cost (Dillman)	5292	1429		
Pilarcitos or San Andres could not be used at (Dillman)	5280			
Used on levees in Kern County (Noyes)	5284	1427		
Used on Oakdale Irrigation District (Dillman)	5278	1426		
Will not handle as much material as steam shovel (Dillman)	5291	1429		
See also, New Era Graders				
GRAVEL				
Spaulding Dam, hauled about 30 miles by rail (Hazen)			5432	1469
GREENE, A. C.				
Actual cost of Crystal Springs Dam obtained from Wenzelburger's report			5434	1469
GRUBBING				
Not included in cost of excavation on Bull Run pipe line, Portland, Ore. (Hazen)			4507–4508	1206
Very heavy in trench excavation Bull Run pipe line, Portland, Ore. (Dillman)	4508	1206		
HAIWEE DAM (NORTH LOS ANGELES AQUEDUCT)				
Cost of (Herrmann)			4971	1334
Cost of trenching (Herrmann)			4982	1338
HAIWEE DAM (SOUTH LOS ANGELES AQUEDUCT)				
Cost of (Herrmann)			4971	1334
Puddle excavation cost (Herrmann)			5116	1377
Trenching cost (Herrmann)			4982	1338
HARTFORD, CONN., DAM				
Built for low price (Hazen)			5425	1466
Description of (Hazen)			5424	1465
HAULING				
Antelope syphon plant, cost of (Dockweiler)	4557	1219		

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HAULING—Continued.				
Based on Calaveras experience with flume material (Herrmann)			5368	1447
Concrete total cost per cubic yard Crystal Springs Dam (Hazen)			5419	1463
Cost of hauling material from steam shovel at Calaveras (Herrmann)			4966–4967	1332
Cost of, on Los Angeles Aqueduct (Lippincott)			5468	1480
Crystal Springs Dam, branch railroad could not be built economically (Hazen)			5419	1463
Crystal Springs Dam, cost of (Lippincott)			5468	1480
Flumes, cost of at Calaveras (Herrmann)			5368	1447
Flumes, cost of operating a truck (Herrmann)			5368	1447
Flumes, cost per ton mile (Herrmann)			5369	1448
Flumes, estimated cost at San Andres (Herrmann)			5369	1448
Franklin Canyon Dam, Los Angeles, details of (Dockweiler)	5033	1353		
Increase from $3.90 to $5.00 due to higher labor, etc.			4490	1200
Length of haul from borrow pits Wild Horse Dam No. 2 (Vallejo, Cal.) (Noyes)	5270	1424		
Material for Crystal Springs Dam, and time required (Hazen)			5413	1461
Material, Crystal Springs Dam, cost of (Hazen)			5413	1461
On earth dams, unit costs by (Dockweiler)	5047	1357		
Puddling, Pilarcitos Dam, distance of (Dockweiler)	5056	1361		
Rip-rap, Pilarcitos Dam, cost of (Dockweiler)	5058	1361		
Riveted pipe, estimated on basis of $5 per ton (Hazen)			4490	1200
Riveted pipe, records show $3.90 per ton as far as they go (Hazen)			4490	1200
Riveted steel pipe expensive (Hazen)			4489	1200
Sand, cost of, for Crystal Springs Dam (Hazen)			5416	1462
Steam shovel at Calaveras (Herrmann)			4967	1332
HAYWARDS, CAL.				
Bids on meters (Dillman)	4482	1198		
HAZEN, ALLEN				
Direct examination (Pipe Riveted)			4163–4177	1090–1104
			4276–4395	1133–1173
			4760–4764	1272–1273
(Dams)			4945–4958	1322–1328
(Pipe Riveted)			5018–5021	1349
(Dams)			5082–5083	1367
			5183–5185	1397–1398
(Flumes)			5213–5222	1405–1408
(Tunnels and Dams)			5408–5461	1459–1478
(Pipe Submerged)			6017–6022	1624–1625

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	Record	Abstract	Record	Abstract
HAZEN, ALLEN—Continued.				
Cross examination (Pipe Riveted)			4178–4179	1104–1105
.....			4488–4565	1190–1222
.....			4827–4841	1292–1296
(Dams)			5083–5110	1367–1375
.....			5829–5840	1576–1580
.....			5851–5862	1582–1585
.....			5914	1601
.....			5950–5952	1610
Re-direct examination (Pipe Riveted)			4566–4574	1222–1225
.....			4765–4772	1273–1277
(Dams)			5111	1375
Re-cross examination			4574–4578	1225–1227
Albany, N. Y., trouble with Bricklayers' Union.			5449	1475
Analysis of cost of finished pipe per lb. without accessories			4352	1159
Appraisal, Crystal Springs Dam, points considered			5412	1460
Appraisal, method used			4287–4304	1137–1141
Ashokan Dam, (N. Y.) description of			5422	1464
Assumes that Spring Valley plant would be reproduced by new management			4487–4488	1199
Auxiliary structures for concrete, cost of, Crystal Springs Dam			5417	1462
Blocks, Crystal Springs Dam, method of building			5439	1471
Brick, description of Albany, N. Y.			5449	1474
Brick harder to lay in cement than common mortar			5452	1476
Brick laying, proper method of			5451	1475
Brickwork, Crystal Springs Dam, quantities and unit costs			5409	1459
Brickwork, estimates sometimes based on cost of concrete			5452	1476
Brickwork, estimated unit costs of			5452	1476
Brickwork, estimated unit costs of Crystal Springs Dam			5448	1474
Brickwork, Spring Valley extract from Derleth report from Engineering News			5453	1476
Breaks, earth dams go out by undermining			5183	1397
Cement bags, percentage that could be returned.			5414	1461
Cement, cost of manufacture would be more near San Francisco than in East			5428	1467
Cement, cost of on Eastern Dams			5427	1467
Cement, cost of Spaulding Dam			5432–5433	1468–1469
Cement, Crystal Springs Dam cost of			5414	1461
.....			5428	1467
Cement, Crystal Springs Dam, quality of			5415	1462
Cement, Kensico Dam (N. Y.) paid for as extra.			5421	1464
Cement, price of at San Mateo			5523	1498

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HAZEN, ALLEN—Continued.				
Columbus, O., Dam, description of			5424	1465
Concrete, city distribution system cost less than Peninsula and Alameda work			5442	1472
Concrete, comparison of costs, Crystal Springs Dam			5443	1472
Concrete, cost less in Alameda system than in Crystal Springs Dam			5441	1471
Concrete, cost of Sunol Filter Galleries			5441	1471
Concrete, Crystal Springs Dam assumed to be made and placed by modern methods			5418	1463
Concrete, Crystal Springs Dam, cost of does not include rock crushing plant			5418	1463
Concrete, Crystal Springs Dam, quantities and unit costs			5409	1459
Concrete, estimated cost of, in balance of Crystal Springs system			5440	1471
Concrete in place, cost of Crystal Springs Dam			5417–5418	1462–1463
Concrete material, cost of, Crystal Springs Dam			5419	1463
Construction, Crystal Springs Dam, method used, best at present time			5418	1463
Contract prices, average for Eastern dams			5430–5431	1468
Corrections in testimony of			4986	1340
Cost figures, Crystal Springs Dam, compared with Lippincott's			5501–5509	1491–1493
Cost galvanizing submerged pipe			4865	1302
Cost of flumes, Hazen used Lawrence's figures			5213	1405
Cost of manufacturing wrought iron pipe			4336	1153
Cross River Dam (N. Y.), description of			5423	1465
Crystal Springs Dam, costs adjusted to Wenzelburger report			5434	1469
Crystal Springs Dam, cost of based on Eastern experience			5430–5431	1468
Crystal Springs Dam, cost of would be increased if joints were duplicated			5437	1470
Crystal Springs Dam estimate compared with Wenzelburger's report			5436	1470
Crystal Springs Dam, estimated cost today practically same as actual cost 25 years earlier			5436	1470
Crystal Springs Dam magnificent piece of masonry construction			5436	1470
Crystal Springs Dam overhead, estimate of			5510	1494
Crystal Springs Dam went through earthquake without injury			5418	1463
Crystal Springs Dam would cost more than similar dam favorably situated			5423	1465
Difference between tuberculation and corrosion in pipe			4315	1145

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	Record	Abstract	Record	Abstract
HAZEN, ALLEN—Continued.				
Difference of $100,000 between Hazen and Dockweiler on structure 11, page 21 (Dockweiler)..	4438	1186		
Earth Dams, why they go out			5183	1397
Equipment for handling sand at Crystal Springs Dam			5415	1462
Estimates made by him in the 90's			4815–4816	
Excavation, cost of for flumes			5455	1476
Excavation riveted pipe, unit prices compared to Ellis	4998	1342		
Excavation, unit costs and quantities Crystal Springs Dam			5408	1459
Expenditure required to bring plant to present need	4280–4284	1134–1136		
Experience with riveted pipe			4375–4376	1168
Explains weights on page 15 of his schedule			4525–4526	1210
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Formula for computing weight of pipe			4333	1151
General remarks on construction of Pilarcitos and San Andres earth dams			4945	1322
General remarks on Spring Valley submerged pipe, date laid, size, etc			4765	1273
Gravel for Spaulding dam hauled about 30 miles by rail			5432	1469
Hartford, Conn., Dam, built for low price			5425	1466
Hartford, Conn., Dam, description of			5424	1466
Has built and designed earth dams similar to Pilarcitos and San Andres			4945	1322
Has made estimates for contemplated construction for Spring Valley			4514	1208
Has made estimates on Pacific Coast water works plants			4488	1199
Hauling concrete total cost per cubic yard, Crystal Springs Dam			5419	1463
Hauling Crystal Springs Dam, branch railroad could not be built economically			5419	1463
Hauling material, Crystal Springs Dam, and time required			5413	1461
Hauling material, Crystal Springs Dam, cost of..			5413	1461
Hauling, sand, cost of, Crystal Springs Dam			5416	1462
Holyoke, Mass., Dam, description of			5425	1466
Holyoke, Mass., Dam, price very low			5425	1466
Joints, Crystal Springs Dam, discussion of			5438	1471
Kensico Dam (N. Y.), description of			5421	1464
Labor, acquired knowledge of conditions on Pacific Coast, by observation and inquiry			4488	1199
Labor, average cost on Eastern dams			5427	1467

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HAZEN, ALLEN—Continued.				
Labor costs, increase between 1913 and 1915 on Eastern dams			5427	1467
Labor cost, Albany, N. Y.			5444	1472
Labor cost, Crystal Springs Dam			5428	1467
			5443	1472
Labor cost, Little River Dam, Mass.			5445	1473
Labor cost, Ogdensburg, N. Y.			5446	1474
Labor cost, Peekskill, N. Y.			5445	1473
Labor cost, Toronto, Canada			5446	1474
Labor cost, Washington, D. C.			5445	1473
Labor cost, Yonkers, N. Y.			5446	1473
Labor material, cost of, Crystal Springs Dam compared with Eastern work			5447	1474
Labor on concrete, cost of Crystal Springs Dam			5418	1463
Leaks, half a hundred dams he knows of leak more or less seriously			5183	1397
Lock Raven Dam (Baltimore) description of			5424	1465
Lumber prices for flumes obtained from Lawrence			5216	1406
Manufacturing steel pipe, costs			4335–4336	1152–1153
Masonry, cost of, Kensico Dam			5421	1464
Masonry dams, general remarks			5410	1459
Material, cost of, Albany, N. Y.			5444	1472
Material, cost of Little River, Mass.			5445	1473
Material, cost of, Ogdensburg, N. Y.			5446	1474
Material, cost of, Peekskill, N. Y.			5445	1473
Material, cost of, Toronto, Canada			5446	1473
Material, cost of, Washington, D. C.			5444	1473
Material, cost of, Yonkers, N. Y.			5446	1473
Pilarcitos Dam, assumed reproduction by economical methods			5403	
Pittsfield, Mass., Dam, description of			5424	1465
Plates, remarks on thickness of, for riveted pipe			4368	1165
Plums, at Crystal Springs Dam, none available			5439	1471
Puddled and charcoal iron, method of manufacture			4317–4321	1146–1148
Qualifications			4163–4179	1099–1105
Quality of Spring Valley Water Co.'s water, storage, sources, etc.			4276	1133
Rip-rap, Pilarcitos average thickness of			5455	1476
Rock, cost of, Crystal Springs Dam			5417	1462
Rock, Crystal Springs Dam, not very good quality			5416	1462
Rock, Crystal Springs Dam, some would be rejected in quarrying			5439	1471
Rock, quarries, Crystal Springs Dam, information obtained from Mr. Schussler and Mr. Lawrence			5416	1462
Sand, amount, required, Crystal Springs Dam			5420	1464
Sand, Crystal Springs Dam, cost of			5415	1462
			5420	1464
Sand, Crystal Springs Dam, difficulty of obtaining			5420	1464

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Sand, for Crystal Springs Dam points from where it could be obtained			5411	1460
Sand, handling equipment, cost of at Crystal Springs Dam			5415	1462
Sand, total cost per cubic yard Crystal Springs Dam			5416	1462
Sources of formation of dams			5425	1466
Spaulding Dam, inquiries made regarding			5432	1468
Springfield, Mass., Dam, description of			5424	1465
Springfield, Mass., Dam, summary showing cost of 32″ riveted pipe line supporting 10% addition to excavation for accessories			4362	1163
Structures of Spring Valley Water Co. well designed and built			4284–4287	1136–1137
Submerged pipe, process of making and laying Spring Valley			4765–4767	1273–1274
Submerged pipe, total cost of laying			4784	1281
Sunol Filter Galleries, unit costs			5457	1477
Tamping backfill, practice is to have two tampers and one shoveler			5352	1442
Timbering, Sunol Filter Galleries, not included in estimate			5457	1477
Time spent in getting information and studying character of iron in pipes of Spring Valley system			4313	1144
Transportation of material for Crystal Springs Dam difficult			5411	1460
Wachusett Dam (Boston) description of			5423	1465
HEADS, PRESSURE				
When getting prices from Lacy Bros. told them what heads would be (Dockweiler)	4615	1237		
HEALY & TIBBITS				
Dockweiler got quotations from, on barge and tugboat service for laying submerged pipe	4782	1279		
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Flumes, caulking and tarring, estimated cost			5372	1449
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Flumes, cost of, Modesto Irrigation Dist			5362	1445
Flumes, cost of South San Joaquin Irrigation District			5363	1446

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HERRMANN, F. C.—Continued.				
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Flumes, items included in cost estimate			5367	1447
Hauling, costs per ton mile for flumes			5369	1448
Hauling, for flumes based on Calaveras experience			5368	1447
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Los Gatos Canyon flume			5365	1446
Lumber for flumes, cost of f.o.b. Millbrae			5365	1446
Lumber waste in flumes figured at 5%			5370	1448
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Puddling, detailed estimate, Modesto Irrigation District			4984	1339
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Sierras, flumes not ordinarily caulked			5372	1449
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Caulking, Dockweiler obtained data in Montgue shop, from	4644	1245		
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HOYOKE, MASS., DAM				
Description of (Hazen)			5425	1466
Price very low (Hazen)			5425	1466
HOWARD CUT				
Modesto Irrigation District, rip-rap comparable to that of Howard Cut (Herrmann)			5355	1443
Paved on one face, not rip-rapped (Hazen)			4953	1326
Trenching, water at 40 feet (Lippincott)			5533	1500
HUSING TO BOURN				
Real estate sale			4283	1136
HYDRAULIC FILL				
Cost of, Modesto Irrigation District (Herrmann)			4972	1334
HYDRAULIC PROCESS				
Stripping by, at Calaveras, estimated cost (Herrmann)			4967	1332
IMPERIAL VALLEY DAM				
Comparison of with Pilarcitos Dam (Herrmann)			4971	1333
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INFORMATION	Record	Abstract	Record	Abstract
In re earth dams, Dillman could obtain none from Schussler	5167	1393		
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Dillman has no faith in inspection of steel in Eastern mills	4693	1257		
Dillman does not know what the practice was in the manufacture of Spring Valley plates	4485	1199		
Dillman has not read Spring Valley specifications for plates	4485	1195		
Great deal of pipe fabricated in Los Angeles did not stand test and inspection of Eastern works (Hazen)			4516	1208
Independent, not allowed in steel mills (Dillman)	4483	1198		
Inspectors usually leave out important items in keeping shop costs (Hazen)			4762	1273
Laying pipe, Dillman would require	4694	1257		
Memorandum of Hazen relating to manufacture of iron plates between 1880 and 1890 (Hazen)			4807	1286
Mill, customary and essential in purchase of riveted pipe (Hazen)			4570	1224
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Of steel armor plates from Government at Harrisburg (Dillman)	4484–4485	1198–1199		
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Pipe riveted, Dockweiler believes in reasonable	4596	1232		
Pipe riveted, "finicky" (Dockweiler)	4599	1232		
Pipe riveted, inspector should be on job all time (Dockweiler)	4596	1232		
Pipe riveted specifications, should require proper (Dockweiler)	4596	1232		
Pipe riveted, would not make additional expense (Dockweiler)	4599	1232		
Plates at mill (Hazen)			4547	1216
Rhodes inspected pipe for P. P. I. E. in Schaw-Batcher Works	4755	1271		
Rhodes inspected steel pipe for Monterey Water Co.	4737	1267		
Spring Valley flume lumber subjected to rigid inspection (Lawrence)			5375	1450
Spring Valley sent their own inspector to Risdon Iron Works during manufacturing of pipe (Dorward)	4924	1317		
Wrought iron, it is proper to have (Dillman)	4693	1257		
Wrought iron might add to cost (Dillman)	4694	1257		

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INSPECTORS				
Maintained at mill during manufacture of pipe for Spring Valley (Hazen)			4321	1148
INTAKES				
Figures referring to not reliable as index to cost of submarine work (Metcalf)			4846	1298
IRON				
Costs more to fabricate steel (Dillman)	4431	1184		
Dillman told that Allan Wood could deliver for 3½c per lb. in San Francisco	4720	1264		
Inspectors maintained at mill by Spring Valley Water Co. (Hazen)			4321	1148
In Spring Valley pipes best obtainable (Hazen)			4322	1148
Steel will rust faster than (Dillman)	4414	1179		
Thickness of No. 9 iron discussed			4463–4468	1194–1195
To replace iron pipe with steel would cost substantially more (Hazen)			4370	1166
IRON BLOOM				
Definition of (Dockweiler)	4639			
Description of (Dockweiler)	4656	1248		
IRON, CAST				
Submerged pipe, Superior, Wis., is cast iron (Hazen)			4829	1292
Vancouver submerged pipe was cast iron (Hazen)			4838	1295
IRON, CHARCOAL				
Cost of for 54" Alameda Pipe line, 5½c per lb. (Hazen)			4354	1160
Method of manufacture (Dockweiler)	4220	1118		
(Hazen)			4320–4321	1147–1148
Prices f.o.b. San Francisco (Hazen)			4838	1295
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IRON, PUDDLED				
15% of all welded pipe used in U. S. is made of puddled iron (Hazen)			4321	1148
For riveted pipe could not be manufactured on large scale today (Hazen)			4371	1166
Method of manufacture (Hazen)			4317–4320	1146–1147
(Dockweiler)	4220	1118		
Of extra quality for riveted pipe in Spring Valley system 4c per lb.			4353	1160
Ordinary for riveted pipe in Spring Valley system 3½c per lb. f.o.b. San Francisco (Hazen)			4354	1160
Prices f.o.b. San Francisco (Hazen)			4327–4329	1149–1150
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JACQUES, H. L.				
Letter in re steam shovel output Los Angeles earth dams (Dockweiler)	5034	1353		

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JOINTS				
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Crystal Springs Dam discussed (Hazen)			5438	1471
(Dillman)	5438	1471		
Crystal Springs Dam, none seen by (Dillman)	5437	1470		
Detailed estimate (Dockweiler)	4781	1279		
Dockweiler's detailed estimate of cost for laying submerged pipe	4784–4791	1281–1282		
Estimated value of (Dockweiler)	4781	1279		
Riveted pipe, method of making explained by (Hazen)			4359	1162
Strength of, never equal to strength of pipe (Dillman)	4712	1263		
Wages for painting (Lawrence)			5331	1437
KENSICO DAM (N. Y.)				
Cement, paid for as extra (Hazen)			5421	1464
Description of (Hazen)			5421	1464
Masonry, cost of (Hazen)			5421	1464
KERN COUNTY				
New Era Graders used on levees (Noyes)	5284	1427		
KNOWLEDGE				
Necessary in making appraisal of water works systems (Dockweiler)	4226	1120		
	4240	1123		
KUICHLING, EMIL				
Leader of all men in U. S. on riveted pipe (Hazen)			4375	1168
LABOR				
Alameda 54" line (Lawrence)			5337	1439
Alameda pipe line through Ellsworth property (1900) (Lawrence)			4402	1176
Albany, N. Y., cost of (Hazen)			5444	1472
Albany, N. Y., trouble with Bricklayers Union (Hazen)			5449	1475
Average working time same at Drum Forebay and Pilarcitos (Herrmann)			5134	1382
Backfill, Lawrence has not figured how much a man could do in a day			5350	1442
Baden Trestle, cost of (Lawrence)			5330	1437
Board figured at 71c a day in 1903 (Lawrence)			5339	1439
Borden Creek Dam, cost of, etc. (Hazen)			5087	1368
California conditions compared with Eastern (Hazen)			4568	1223
Carpenters wages (Lawrence)			5306–5308	1432–1453
			5328	1437
Carpenter work on San Andres pipe line explained (Lawrence)			5303	1432

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
LABOR—Continued.				
Climate and location would increase price of work at Pilarcitos as compared with Drum Forebay (Herrmann)			5133	1382
Colorado River levees, class and cost of (Herrmann)			4963	1331
Comparison in efficiency for 8 and 10 hour day (Ellis)	5233	1413		
Comparison made by City Engineer of Boston (Metcalf)			4576	1226
Construction camps usually maintained for men on large jobs (Lawrence)			5317	1435
Costs here would not be 20% greater than in the East (Dorward)	4922	1317		
Costs kept separately (Lawrence)			4400	
Cost of advance 80% between 1898 and 1914 (Lawrence)			4401	1175
Cost of for 10 hours, Wild Horse Dam No. 2 (Vallejo, Cal.) (Noyes)	5271	1425		
Cost on steel pipe for Monterey Water Co. (Rhodes)	4750	1270		
Crystal Springs Dam, cost of (Hazen)			5428–5443	1467–147[illegible]
Crystal Springs Dam, cost of compared with Eastern work (Hazen)			5447	1474
Crystal Springs Dam, cost of on concrete (Hazen)			5418	1463
Dams, cost, average on Eastern (Hazen)			5427	1467
Dams, cost, increase between 1913-1915 on Eastern dams (Hazen)			5427	1467
Dipping, costs on riveted pipe (Lawrence)			5323–5324	1436
Dorward knew wages of men employed at Risdon Iron Works	4893	1310		
Dorward says men worked 10 hours a day up to 1902	4893	1310		
Drum Forebay, cost of (Herrmann)			5130	1381
Earth dams, comparison of costs on East and West (Hazen)			5087	1368
Earth dams, Dockweiler figured 9 hour day at Pilarcitos	5207	1404		
Earth dams, eight hour day used as basis in estimating (Hazen)			5100	1372
Earth dams, hours, etc., observed in East in clearing for earth dams (Hazen)			5100	1372
Earth dams, rate paid for clearing (Hazen)			5100	1372
Efficiency, etc., general remarks (Ellis)	5257	1420		
	5260	1421		
Efficiency, not as high as 10 years ago (Dorward)	4929	1319		
Efficiency of on riveted pipe (Lawrence)			5319	1435
Efficiency not greater on Pacific Coast than in the East (Hazen)			4575	1226

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
LABOR—Continued.				
Eight hour day assumed in reproduction of Spring Valley system (Lawrence)			5344	1441
Eight hour day observed in San Mateo County and nine hours in Alameda County (Lawrence)			4409	1178
Eight hour day observed in San Mateo, ten hours at Calaveras (Herrmann)			4964	1331
Ellis familiar with price of in San Francisco bay section	4886	1308		
Excavation for riveted pipe, cost of (Lawrence)			5332	1438
Experience with (Lawrence)			5299	1431
Explanation of column 5, Exhibit 100 (Dockweiler)	4729	1266		
Fabrication cost, .6 of a cent per lb. (Dockweiler)	4648	1247		
Fabrication, don't remember any man who said shop labor cost 6/10 of cent (Dockweiler)	4634	1242		
Flumes, Herrmann familiar with rules of steam shovel men			5373	1449
Foreign and cheap labor is not used in fabricating pipe in Eastern pipe works (Hazen)			4493	1201
Foreman on pipe work, wages of (Lawrence)			5327	1436
			5336	1439
			5343	1440
General remarks on labor and union, etc. by Hazen			5090–5091	1369–1370
Hours of work were reduced 20% which would make the total increased cost of labor 32% (Dorward)	4917	1315		
Increase in cost of hauling riveted pipe from $3.90 per ton to $5 (Hazen)			4490	1200
Is 20% more efficient here than in East (Dockweiler)	4624	1240		
Laborers, wages of (Lawrence)			5306–5308	1432–1433
Little River, Mass., cost of (Hazen)			5445	1473
Los Angeles Aqueduct (Herrmann)			5126	1380
Made inquiries in San Francisco condition of (Hazen)			4568–4574	1223–1225
Method of expanding from 10 hour day to 8 hour (Lawrence)			5301–5302	1431
Millbrae force main (Lawrence)			4403	1176
Modesto Irrigation Dam, wage schedule (Herrmann)			5142	1385
Not as efficient now as in the old days (Dorward)	4918	1316		
Not much increase in labor costs from 1900 to 1912 (Moebus)	4935	1320		
Obtained information from Mr. Riffle (Dockweiler)	4632	1242		
Ogdensburg, N. Y., cost of (Hazen)			5446	1474
On earth dams, ordinary labor will do nearly twice as much as Mexican labor (Dillman)	5016	1348		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
LABOR—Continued.				
On earth dams, 10 hours a day, not less than 9 hours (Dillman)	5015	1348		
On earth dams, wages $2.50 per day in 1913 (Dillman)	5015	1348		
Pacific Coast, acquired familiarity with labor conditions on by observation and inquiry (Hazen)			4488	1199
Peekskill, N. Y., cost of (Hazen)			5445	1473
Pilarcitos Dam, cost of (Hazen)			5089	1369
Pilarcitos Dam, percentage of cost (Herrmann)			5144	1385
Pipe, price of, has increased since laying most of Spring Valley pipe (Hazen)			4346	1156
Pipe, riveted, price of does not control the manufacture (Hazen)			4518	1209
Pleasanton pipe line, figures not expanded to 8 hours for 1913 (Lawrence)			5344	1441
Risdon shop labor, etc., on Spring Valley riveted pipe (Dorward)	4914–4915	1315		
Segregation of, at Portland, Ore. (Dillman)	5000	1343		
Smith, Francis Co. maintained open shop (Moebus)	4935	1320		
S. P. costs in neighborhood of San Francisco (Hazen)			5098	1371
S. P. payrolls data obtained from (Hazen)			5097	1371
S. P. payrolls referred to (Hazen)			4568	1223
.....			5089	1369
Stone Dam Aqueduct (Lawrence)			4402	1176
Submerged pipe, cost of laying (Dockweiler)	4874	1304		
Submerged pipe, cost of would be greater at present (Hazen)			4770	1276
Sufficient efficient labor for pipe manufacturing could not be obtained on Pacific Coast (Hazen)			4520	1209
Tabeaud Dam, general remarks (Ellis)	5248–5250	1417–1418		
The increase of wages from 1884 to 1913 was 12% (Dorward)	4917	1315		
Toronto, Can., cost of (Hazen)			5446	1473
Trenches, common labor not used in lagging (Lawrence)			5305	1432
Trenching, earth dams (Dockweiler)	5050	1358		
Trenching, earth dams, Dockweiler figured 9 hours day labor $2.50	5048	1357		
Trenching, earth dams, wages for (Dockweiler)	5050	1358		
Trenching machine, use of, a saving over hand labor (Dockweiler)	4814	1288		
Union rate in San Mateo County for common labor $2.50 per day (Lawrence)			4408	1177
Vancouver and San Francisco conditions (Hazen)			4840	1296
Vancouver pipe line (Hazen)			4840	1296
Wages assumed at Pilarcitos Dam (Ellis)	5233	1413		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
LABOR—Continued.				
Wages for painting joints riveted pipe (Lawrence)			5331	1437
Wages have been the same since 1903 (Lawrence)			5338	1439
Wages paid for labor for clearing site for earth dams (Hazen)			5099	1372
Wages paid on Tabeaud Dam (Ellis)	5233	1413		
Wage schedule, not much difference in between Los Angeles and San Francisco (Dockweiler)	4455	1192		
Wage schedule, used in estimating Peninsula dams (Herrmann)			4973	1334
Washington, D. C., cost of (Hazen)			5445	1473
Watchman's time on San Andres explained by (Lawrence)			5305	1432
Western Steel & Pipe Co. work 9 hour day, Schaw-Batcher 8 hour, pay same rates (Dockweiler)	4625	1240		
Would organize in San Mateo County (Lawrence)			5322	1435
Yonkers, N. Y., cost of (Hazen)			5446	1473
LABORERS				
Wages of (Lawrence)			5306–5308	1432–1433
LACY BROS.				
Baker Iron Works figures higher than (Dockweiler)	4622	1239		
Bids on San Diego riveted pipe (Dockweiler)	4798	1284		
Caulking inside and out, no provision for (Dockweiler)	4618	1238		
Contract of, with Los Angeles (Dockweiler)	4452	1191		
Fabrication of riveted pipe, assumed to be within 60 miles of San Francisco (Dockweiler)	4626	1240		
Inspection not mentioned in getting prices from (Dockweiler)	4615	1236		
Letter from in re fabrication of riveted pipe (Dockweiler)	4443–4447	1187–1189		
Letter from in re weights riveted pipe (Dockweiler)	4447	1189		
24% lower than Baker Iron Works on one weight of iron (Dockwieler)	4638	1243		
Weight of various sizes of pipe (Dockweiler)	4446	1189		
When getting prices told them verbally what pressure heads would be (Dockweiler)	4615	1237		
When asking prices Dockweiler told them he was making appraisal for San Francisco	4613	1236		
LAGGING				
Common labor not used in trenches (Lawrence)			5305	1432
Cost of at San Andres and Pilarcitos (Dillman)	5156	1389		
For trench not included in Dillman's original estimate	5168	1393		
Trench, allowed for lagging in estimate (Herrmann)			5023	1350

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
LAGGING—Continued.				
Trench, considered lagging in estimate (Hazen).			5022	1350
Trenching, Dillman did not consider in his estimate	5021	1349		
LAKE ARTHUR DAM				
Cost of, built by Pac. Gas & Elec. Co. (Herrmann)			4970	1333
Material used in construction (Herrmann)			5138	1383
Not as high as Pilarcitos or San Andres Dams (Herrmann)			5139	1384
LAKE HONDA DISTRICT				
Service largest and most important (Hazen)			4278	1134
LAKE VALLEY DAM				
Cost of, built by Pac. Gas & Elec. Co. (Herrmann)			4970	1333
Dimensions (Herrmann)			5137	1383
LA MESA DAM				
Dillman made report on to New England Trust Co.	5012	1347		
LAWRENCE, W. B.				
Direct examination (Pipe, riveted)			4275	1132
			4395–4410	1173–1178
(Flumes)			5374–5379	1449–1451
Cross-examination (Pipe, riveted)			5297–5352	1430–1442
Alameda pipe line, excavation quotations from Minute Book "D"			5333	1438
Backfill, unit costs			5349	1441
Carey, 20 foot lengths for submerged pipe shown in testimony are not correct			5324	1436
Carey, quotations from 1904 testimony in re dipping riveted pipe			5323	1436
Carpenters, wages of			5306–5308	1432–1433
Carpenters, wages of on riveted pipe work			5328	1437
Carpenter work on San Andres pipe line explained			5303	1432
Construction camps maintained for men on large jobs			5317	1435
Corrections in original table on cost of riveted pipe			5297	1430
Errors, boilermakers wages, reduction of in 1913			5344	1441
Excavation, considered same methods would be used in 1913 on pipe lines			5312	1433
Excavation for flumes, unit costs			5377	1450
Flumes, cost, Hazen used Lawrence's figures			5213	1406
Flumes, methods of construction used by Spring Valley Water Co.			5375	1450
Labor, common not used in lagging trenches			5305	1432
Labor costs, dipping riveted pipe			5323–5324	1436
Labor, cost of, on excavation for riveted pipe			5332	1438
Labor, efficiency of, on riveted pipe			5319	1435
Labor, experience with			5299	1431
Labor, wages has been the same since 1903			5338	1439
Laborers, wages			5306–5308	1432–1433

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
LAWRENCE, W. B.—Continued.				
Lumber for Spring Valley flumes subjected to rigid inspection			5375	1450
Lumber, no allowance for waste on flumes			5370	1448
Pipe riveted, records show partial cost of			5327	1436
Pleasanton pipe line has served purpose for which it was built			5340	1439
Qualifications			4275	1132
Tamping, methods used by Spring Valley Water Co. on riveted pipe			5352	1442
Teams were hired by the day on pipe line work			5314	1434
Trenching, has had no experience with machines			5312	1433
Watchman's time on San Andres P. L. explained			5305	1432
Weights of Alameda P. L. taken from specifications and contract			5297–5298	1430
Weights were used with some modifications (Hazen)			4710	1262
LAYING				
Analysis of cost (Dockweiler)	4659	1249		
Comparison of Dockweiler's cost and costs in Schaw-Batcher Co. letter, for 44" pipe	4663	1249		
Connecticut River pipe was laid differently than Spring Valley Water Co. pipe (Hazen)			4827	1292
Cost, 36", 37" and 44" pipe (Dockweiler)	4650	1247		
Costs of were not part of Risdon Shop account on riveted pipe for Spring Valley (Dorward)	4911	1314		
Dorward was familiar with the Spring Valley specifications for laying and fabricating	4895	1310		
Pipe, Dillman would require inspection	4694	1257		
Pipe, riveted, Schaw-Batcher letter quoting prices (Dockweiler)	4653	1248		
Risdon Iron Wks., details of work on Spring Valley pipe (Dorward)	4909			
Risdon time-keepers reported directly to office on laying of Spring Valley riveted pipe (Dorward)	4911	1314		
Spring Valley pipe by Risdon Iron Works, table by Dorward showing costs	4891	1309		
	4899	1311		
Submerged pipe, depth would make a slight difference in (Dillman)	5007	1346		
Submerged pipe, Dillman made no segregation for cost of laying	4854	1300		
Submerged pipe, Dockweiler's estimate	4875	1304		
Submerged pipe, equipment would be less under present conditions (Dockweiler)	4873	1304		
Submerged pipe, is extra hazardous work (Hazen)			4832	1293
Submerged pipe, labor costs (Dockweiler)	4874	1304		
Submerged pipe, Portland, Ore., method of (Hazen)			4830	1293

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
LAYING—Continued.				
Submerged pipe, total cost of (Dockweiler)	4784	1281		
Submerged pipe, Vancouver line, methods of			4839	1296
LAYOFFS				
Pilarcitos Dam, Dockweiler would not pay for teams during delays and layoffs	5205	1403		
Steam shovel work, Dockweiler's estimate would take care of at Pilarcitos	5041	1356		
Steam shovel work, Pilarcitos, Dockweiler made allowance of 10% for	5042	1356		
LEAD				
Submerged pipe, Dockweiler's weight and cost per lb. on	4780	1279		
Weight and cost per lb. on submerged pipe joints (Hazen)			4780	1279
Weight, Dockweiler's calculations correct, but no allowance for loss and waste in submerged pipe joints (Hazen)			4819	1290
LEAKAGE				
Earth dams, Hazen says half a hundred dams he knows of leak more or less seriously			5183	1397
Pilarcitos dam, was in the rock and had nothing to do with dam (Herrmann)			4991	1341
Such a dam as Dillman proposes at Pilarcitos would probably leak (Dillman)	5175	1395		
Wild Horse Dam No. 2 (Vallejo, Cal.) none in (Noyes)	5265	1423		
LENGTHS				
Submerged pipe, Spring Valley and Connecticut River lines (Hazen)			4827	1292
Submerged pipe, Spring Valley length of each line is 6300 feet (Hazen)			4863	1302
Submerged pipe, Vancouver line (Hazen)			4838	1295
Used by Dockweiler in Spring Valley submerged pipe were agreed to when inventory was made (Dockweiler)	4864	1302		
LEVEES				
Clearing on Colo. River, cost of (Herrmann)			4963	1330
LIPPINCOTT, J. B.				
Direct examination (Dams)			5462–5516	1478–1495
Cross-examination (Dams)			5517	1496
			5535	1501
			5612	1521
Re-direct examination (Dams)			5612	1521
Cement, combination in selling			5469	1480
Cement, cost at Los Angeles			5471–5473	1481–1482
Cement, cost of at Mojave			5517B	1496
Cement, cost of at Santa Barbara			5470	1481
Cement, cost of at Spaulding Dam			5520	1497

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
LIPPINCOTT, J. B.—Continued.				
Cement, cost to manufacture			5471	1482
Cement, price paid by Spring Valley for use at Calaveras 1914			5520	1497
Concrete, cost of at government dams			5529–5530	1499
Concrete, cost of mixing and placing			5497	1484
Concrete, cost of mixing and placing on Gibraltar Dam, Santa Barbara			5481	1484
Concrete, Crystal Springs Dam, estimated cost of			5483	1485
Concrete, Crystal Springs Dam, mix assumed			5468	1480
Concrete dams, experience with			5516	
Concrete, estimated cost of mixing at Crystal Springs			5531	1500
Concrete mix assumed in appraisal of Crystal Springs Dam			5468–5481	1480–1484
Concrete, mixing of, on government dams			5528–5530	1499
Concrete on government dams, cost of			5479	1484
Concrete, proposed methods of mixing and placing			5482	1485
Concrete work, assumes most modern methods			5482	1485
Cost figures, Crystal Springs Dam, compared with Hazen's			5501–5508	1491–1493
Crystal Springs Dam, assumed a monolithic dam in appraisal			5467	1480
Crystal Springs Dam, made valuations as of Dec. 31, 1913			5467	1480
Elizabeth Tunnel, cost of excavating shaft at			5534	1500
Excavation, Crystal Springs Dam, tower, cost of			5534	1501
Puddling, Crystal Springs Dam, detail cost			5486	1486
Puddling, estimated cost on Crystal Springs Dam			5486	1486
Qualifications			5461–5462	1478
Rock, Crystal Springs Dam, detailed cost of			5477	1483
Rock, weight of, Crystal Springs Dam			5477	1483
Stripping, Crystal Springs Dam, estimated cost			5484	1485
....			5531	1500
LITIGATION				
Calaveras Dam work, retarded by (Herrmann)			5149	1387
LITTLE RIVER, MASS. (Dam)				
Labor, cost of (Hazen)			5445	1473
Material, cost of (Hazen)			5445	1473
LLEWELLYN IRON WORK				
Bid on San Diego riveted pipe (Dockweiler)	4798	1284		
Contract of, with Los Angeles (Dockweiler)	4454	1191		
LOADING				
Ellis has had no experience in loading wagons with steam shovel	5236	1414		
Operating wagons, methods used at Calaveras Dam (Elliott)			5391	1455
Steam shovels load more rapidy into cars than into wagons (Ellis)	5236	1414		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
LOCATION				
Moebus doesn't know location of Spring Valley pipe made by Francis Smith Co.	4931	1319		
LOCH RAVEN DAM (Baltimore)				
Description of (Hazen)			5424	1465
LOS ANGELES				
Bids for 30" steel pipe 5/16" for (Dockweiler)	4454	1191		
Cement, cost of at (Lippincott)			5471–5473	1481–148
Cement, price paid by L. A., 1914 (Lippincott)			5518	1497
Cement, prices higher at Riverside than at Los Angeles (Lippincott)			5521	1497
Contract price, for delivery of pipe at trench, caulking and riveting (Hazen)			4338	1153
Cost records, copies by J. G. White Co. (Dockweiler)	4585	1229		
Dove Canyon job, details (Hazen)			4500–4501	1204
Dove Canyon job, no guide on Spring Valley work (Hazen)			4501	1204
Excavation cost on 36" steel pipe (Dockweiler)	4462	1193		
Excavation cost on 40" line (Dockweiler)			4459–4461	1192
Fabrication, cost of pipe in L. A. higher than in East (Hazen)			4516	1208
Pipe, bought to weight (Hazen)			4528	1211
Prepared plans and specifications for pipe work in (Dockweiler)	4590	1229		
Riveted pipe, data furnished by Mr. Mulholland (Hazen)			4500	1204
Riveted pipe, fabricated in L. A. did not stand test and inspection of Eastern works (Hazen)			4516	1208
Syphon pipe on aqueduct not dipped, but painted (Hazen)			4555	1218
Wage schedule between, and S. F., not much difference (Dockweiler)	4455	1192		
LOS ANGELES AQUEDUCT				
Administrative expense not charged against work (Lippincott)			5506	1493
Antelope Syphon, cost of (Hazen)			4550	1217
Auxiliary expense (Hazen)			4559	1220
Blasting at San Fernando, method of (Dockweiler)	5198	1401		
Cement, cost of at Mojave and Colton (Lippincott)			5517B	1496
Cement, Tufa, cost of blending (Lippincott)			5517A	1496
Construction work not comparable to Spring Valley work (Lippincott)			4555	1218
			4562	1221
Costs, methods of keeping			5488	1487
Cost not to be taken as basis in this case (Metcalf)			4583	1229

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
LOS ANGELES AQUEDUCT—Continued.				
Cost work is not cheaper than by Hazen's method			4957	1328
Dam construction not comparable to Pilarcitos Dam (Herrmann)			5114–5115	1376–1377
Dams, cost of (Herrmann)			4971	1333
Data used, furnished by Mulholland (Hazen)			4502	1204
Details of job (Hazen)			4502	1204
Dockweiler does not know what the material was on Dry Canyon Dam	5191	1399		
Dockweiler familiar with cost of	5029	1352		
Dockweiler obtained from Mr. Mulholland records of riveted steel pipe	4671	1251		
Dry Canyon Dam, cost of (Herrmann)			4971	1334
Earth dams, capacity of steam shovels (Dockweiler)	5034	1353		
Earth dams, Dockweiler has detail cost of	5033	1353		
Earth dams, letter from Mr. H. L. Jacques in re steam shovel output (Dockweiler)	5034	1353		
Earth dams, steam shovel output on an average (Dockweiler)	5033	1353		
Excavation for puddle at South Haiwee Dam, cost of (Herrmann)			5116	1377
Fabrication, cost of on syphon pipes (Hazen)			4551	1217
Fabrication and delivery of pipe, no contract prices for (Hazen)			4561	1220
Franklin and San Fernando Dams visited (Elliott)			5404	1458
Franklin Canyon Dam, details of haul at (Dockweiler)	5033	1353		
Franklin Canyon Dam, did not know cost when appraisal was made (Hazen)			5108	1374
Franklin Canyon Dam, material used on (Dockweiler)	5191	1399		
Franklin Canyon Dam, method of construction (Dockweiler)	5194	1400		
Franklin Canyon Dam, was permanent work (Dockweiler)	5190	1390		
Haiwee Dam (North), cost of (Herrmann)			4971	1334
Haiwee Dam (South), cost of (Herrmann)			4971	1334
Hauling, cost of (Lippincott)			5468	1480
Indirect charges explained (Herrmann)			5112–5114	1376
Indirect charges on pipe were very great (Hazen)			4558	1219
Labor on (Herrmann)			5126	1380
Material handled by wagon loads cannot be computed (Elliott)			5405	1458
Overhead charges (Herrmann)			4981	1337
Overhead items included in auxiliary expense (Lippincott)			5488	1487

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
LOS ANGELES AQUEDUCT—Continued.				
Overhead, office should be added to indirect charges on (Herrmann)			5112	1376
Overhead, 38.85% classed as indirect charges on (Herrmann)			5111–5112	1375–1376
Photographs, description of (Elliott)			5392	1455
Pipe in schedule furnished by Mulholland fabricated under specifications (Dockweiler)	4685	1254		
Puddle fill, cost of, Dry Canyon Dam (Dockweiler)	5199	1402		
Puddling, Dry Canyon Dam, cost of (Dockweiler)	5062	1362		
Roads and trails, items (Lippincott)			5489	1488
Specification 268, Los Angeles, were drawn on a weight basis (Dockweiler)	4610	1235		
Steam shovel capacity, Lower Franklin Dam (Elliott)			5384	1453
Steam shovel capacity, Franklin Canyon (Dockweiler)	5192	1400		
Steam shovel capacity, San Fernando Dam (Elliott)			5384	1453
Steam shovel, character of material worked by (Elliott)			5385	1453
Steam shovel, conditions at San Fernando and Franklin Dams better than at Calaveras (Elliott)			5386	1453
Steam shovel delivery, San Fernando Dam (Elliott)			5383	1452
Steam shovel delivery, Upper Franklin Dam (Elliott)			5384	1453
Steam shovel, voids in material handled by, San Fernando Dam (Elliott)			5391	1455
Steam shovel work, conditions at Pilarcitos and San Andres not comparable to San Fernando and Franklin Dams (Elliott)			5389–5390	1454
Steam shovel work, delays on not recorded (Elliott)			5405	1458
Steam shovel work, Franklin Canyon Dam, Dockweiler has records of	5033	1353		
Steam shovel work, Franklin Canyon Dam, record of (Dockweiler)	5037	1354		
Supporting data from, on puddling (Dockweiler)	5062	1362		
Syphons, notes on cost of (Hazen)			4549	1217
Syphon ¼", cost of (Hazen)			5402	1204
Trenching, cost of (Herrmann)			5155	1388
Trenching, North Haiwee Dam, cost of (Herrmann)			4982	1338
Trenching, South Haiwee Dam, cost of (Herrmann)			4982	1338

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LOS ANGELES AQUEDUCT—Continued.				
Weight records of Antelope Syphon not correct (Metcalf)			4553	1218
LOS GATOS CANYON FLUME				
Cost of (Herrmann)			5365	1446
LOSSES, MISCELLANEOUS				
Overhead, Crystal Springs Dam (Lippincott)			5605	1519
LUMBER				
Crystal Springs Dam, cost of at San Mateo (Lippincott)			5478	1484
Crystal Springs Dam, freight paid (Lippincott)			5478	1484
Flumes, cost of f.o.b. Millbrae (Harrmann)			5365	1446
Flumes, lumber subjected to rigid inspection by Spring Valley Water Co. (Lawrence)			5375	1450
Flumes, prices obtained from Lawrence (Hazen)			5216	1406
Flumes, requirements and specifications (Lawrence)			5374	1449
P. P. I. E. was not all purchased by John Hooper (Dillman)	4486	1199		
Price P. P. I. E. $11 per thousand including drayage (Dillman)	4483	1198		
MACHINERY				
Used in the manufacture of steel pipe for Monterey Water Co. (Rhodes)	4742–4743	1268		
MANHOLES				
Cost of, for riveted pipe at Portland, Ore. (Hazen)			4341	1155
MARKET CONDITIONS				
Pipe, since 1907 (Hazen)			4817	1290
MASONRY				
Crystal Springs Dam, magnificent piece of construction (Hazen)			5436	1470
Kensico Dam (N. Y.), cost of (Hazen)			5421	1464
MATERIALS				
Adaptable for use at Calaveras and Pilarcitos Dams (Elliott)			5398	1457
Alamo Dam, Imperial Valley, not selected (Herrmann)			5141	1384
Albany, N. Y., cost of (Hazen)			5444	1472
Borden Brook Dam (Springfield, Mass.) (Hazen)			5083–5085	1367–1368
Calaveras Dam, compacting of (Elliott)			5391	1455
			5395	1456
Character of, in trenching, shown by inspection below Pilarcitos (Dockweiler)	5052	1359		
Character of, on which steam shovels worked, Los Angeles Aqueduct (Elliott)			5385	1453
Character of, used in embankment of Pilarcitos Dam (Hazen)			5086	1368

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	Record	Abstract	Record	Abstract
MATERIALS—Continued.				
Concrete, cost of, Crystal Springs Dam (Hazen)			5419	1463
Cost of material placed by steam shovel at Calaveras (Herrmann)			5143	1385
Cost of, on submerged pipe would be about same today (Hazen)			4770	1276
Cost of Vancouver submerged pipe (Hazen)			4838	1295
Cost of various materials for earth dams (Hazen)			4951	1325
Crystal Springs Dam, amount to be hauled, and time required (Hazen)			5413	1461
Crystal Springs Dam, cost of, compared with Eastern work (Hazen)			5447	1474
Dry Canyon Dam, Dockweiler does not know what it was	5191	1399		
Hauling for Crystal Springs Dam, cost of (Hazen)			5413	1461
In vicinity of Pilarcitos Dam, could be handled very comfortably with steam shovels (Dillman)	5170	1393		
Lake Arthur Dam, used in construction (Herrmann)			5138	1383
Little River, Mass., cost of (Hazen)			5445	1473
L. A. Aqueduct, handled by wagon loads cannot be computed (Elliott)			5405	1458
Methods of separating for embankments on earth dams (Hazen)			5096	1371
Ogdensburg, N. Y., cost of (Hazen)			5446	1474
Peekskill, N. Y., cost of (Hazen)			5445	1473
Percentage of shrinkage in embankment materials (Ellis)	5238	1415		
Pilarcitos Dam, could not be economically segregated with steam shovel (Elliott)			5396	1457
Pilarcitos Dam, would have to be within 1000 or 1200 feet (Ellis)	5237	1414		
Placing, cost less with steam shovel than with scrapers at Pilarcitos and San Andres (Ellis)	5235	1413		
Puddling not necessary if compacted (Dillman)	5162	1391		
Rip-rap, suitable material more available on Modesto works than on Pilarcitos and San Andres (Herrmann)			5359	1444
Rolled in 12" layers, seen by Ellis	5239	1415		
Shrinkage of, in embankments	5160	1391		
Submerged pipe, estimate of (Dockweiler)	4875	1304		
Tabeaud Dam, character of (Ellis)	5243	1416		
Toronto, Canada, cost of (Hazen)			5446	1473
Transportation of, for Crystal Springs Dam, difficult (Hazen)			5411	1460
Used on Franklin Canyon Dam (Dockweiler)	5191	1399		
Voids in, handled by steam shovel, San Fernando Dam (L. A.) (Elliott)			5391	1455

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	Record	Abstract	Record	Abstract
MATERIALS—Continued.				
Washington, D. C., cost of (Hazen)			5444	1473
Wild Horse Dam No. 2 (Vallejo, Cal.), character of (Noyes)	5262	1421		
Yonkers, N. Y., cost of (Hazen)			5446	1473
MERCED PIPE LINE				
Has small amount of inferior pipe (Hazen)			4522	1209
Specifications not furnished by Spring Valley for pipe (Hazen)			4522	1209
METCALF, LEONARD				
Direct examination (Pipe, riveted)			4180–4191	1105–1110
			4579–4583	1227–1229
			4842–4845	1296–1298
Cross examination (Pipe, riveted)			4191	1110
			4846–4849	1298–1299
Antelope Syphon, Los Angeles Aqueduct, weight records not correct			4553	1218
City Engineer of Boston, labor comparisons made by			4576	1226
Cost estimated for reproduction of Crystal Springs Dam			5435	1470
Qualifications			4180–4191	1105–1110
Submerged pipe laid by Metcalf, details			4841–4848	1296–1298
METERS				
Hayward job, bids for (Dillman)	4482	1198		
METHODS				
Blasting at San Fernando Dam, in steam shovel pit (Dockweiler)	5198	1401		
Computing costs, submerged pipe, Portland, Ore. (Dillman)	5000	1343		
Construction of Franklin Canyon Dams (Dockweiler)	5194	1400		
Dockweiler's, of estimating cost of riveted pipe (Dockweiler)	4432	1184		
Dorward's, figuring cost of riveted pipe (Dorward)	4894	1310		
Figuring steam shovel costs (Dockweiler)	5043	1356		
Getting steam shovel into Pilarcitos Dam (Dillman)	5180	1396		
Getting steam shovel into Pilarcitos (Dockweiler)	5187	1398		
Of computing unit costs of stripping (Dockweiler)	5031	1352		
Of computing weights, riveted pipe (Dockweiler)	4438	1186		
Of puddling at Pilarcitos (Dillman)	5159	1390		
Puddling, description of various kinds (Dillman)	5025	1350		
Riveting, adopted by Dockweiler (Dockweiler)	4591	1229		
Used in chipping (Dockweiler)	4640	1244		

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MEXICAN				
Labor, on earth dams, ordinary labor will do nearly twice as much as Mexican labor (Dillman)	5016	1348		
MILLBRAE				
Dillman examined pipes taken up at (Dillman)	4695	1258		
Lumber for flumes, cost of f.o.b. (Herrmann)			5365	1446
Records, method of keeping (Lawrence)			5325	1436
MILLBRAE PUMPS				
Force main 30", Lawrence's analysis of (Lawrence)			4403	1176
MINNEAPOLIS				
Cost of 48" and 54" riveted pipe (Hazen)			4510	1207
48" and 54" riveted pipe used as a comparison for estimating Spring Valley pipe (Hazen)			4511	1207
MINUTE BOOK "F"—SPRING VALLEY WATER CO.				
Bids and quotations on pipe (Dockweiler)	4470	1195		
Bid from Schaw-Batcher Co. on riveted pipe explained (Hazen)			4471–4472	1195–1196
MIXING				
Concrete, and placing on Gibraltar Dam, Santa Barbara (Lippincott)			5481	1484
Concrete, and placing, Lippincott's proposed method			5482	1485
Concrete, cost of (Lippincott)			5479	1484
Concrete, mix assumed in appraisal Crystal Springs Dam (Lippincott)			5468	1480
Concrete, mix used at Crystal Springs (Lippincott)			5534	1500
Concrete, estimated cost of mixing at Crystal Springs (Lippincott)			5481	1481
			5531	1500
Concrete mix, government dam (Lippincott)			5528	1499
Concrete on government dams (Lippincott)			5528–5530	1499
MODESTO IRRIGATION DISTRICT				
Cost of hydraulic fill (Herrmann)			4972	1334
Cost of trenching (Herrmann)			4982	1338
			5155	1389
Dallas-Warner fill, methods of construction (Herrmann)			5141	1384
Dimensions of dam (Herrmann)			5142	1385
Flumes, cost of (Herrmann)			5362	1445
Puddling, contract price for (Herrmann)			4984	1339
Puddling, method of (Herrmann)			4984	1339
Rip-rap, bids on (Herrmann)			5356	1443
Rip-rap, contract prices (Herrmann)			5353	1442
Rip-rap, not comparable to that at Howard Cut (Herrmann)			5355	1443

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MODESTO IRRIGATION DISTRICT—Continued.				
Rip-rap, specifications for (Herrmann)			5359	1444
Rip-rap, suitable material more available on Modesto works than at Pilarcitos and San Andres (Herrmann)			5359	1444
Wage schedule (Herrmann)			5142	1385
Work partly paid for in bonds (Herrmann)			5142	1385
MOEBUS, F. W. G.				
Direct examination (Pipe, riveted)	4930–4935	1319–1320		
Cross-examination (Pipe, riveted)	4936–4941	1320–1321		
Cost data not preserved by	4931	1319		
Fabrication cost on riveted pipe would be about $1.30	4935	1320		
Familiar with Francis Smith shop costs	4930	1319		
Labor costs, not much increase in from 1900 to 1912	4935	1320		
Pipe lines built by, for Spring Valley Water Co.	4939	1319		
Profit on riveted pipe would run from 15% to 25% between 1907 and 1912	4935	1320		
Qualifications	4929	1319		
MOJAVE				
Cement, cost of at (Lippincott)			5517B	1496
MONTAGUE & CO., W. W.				
Made steel pipe for Monterey Water Co (Rhodes)	4737	1267		
MONTEREY WATER CO.				
Caulking steel pipe, method of (Rhodes)	4751	1270		
Cost of power per month for making steel pipe (Rhodes)	4742	1268		
Difficult to get steel pipe tight (Rhodes)	4750	1270		
Dockweiler knew of cost of work	4736			
Fabricating, improved methods of would lessen cost (Rhodes)	4755	1271		
Fabricating pipe, methods of have improved (Rhodes)	4754–4755	1271		
Labor, cost on steel pipe (Rhodes)	4750	1270		
Power required to drive compressor in manufacture of steel pipe for Monterey Water Co. (Rhodes)	4753	1271		
Rhodes did not check cost with Montague shop cost on steel pipe	4752	1271		
Rhodes does not know what company paid for steel pipe	4750	1270		
Rhodes inspected steel pipe for company	4737	1267		
Rhodes kept analysis of shop costs on steel pipe (Rhodes)	4739	1267		
Rhodes obtained wages paid on steel pipe from payroll	4752	1271		

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MONTEREY WATER CO.—Continued.				
Specifications for Monterey Water Co. steel pipe required hydraulic pressure of 175 lbs. per sq. in. before dipping (Rhodes)	4739	1267		
Steel pipe, general remarks re the manufacture of (Rhodes)	4744–4749	1268–1270		
Steel pipe, length and size made for Monterey Water Co. by W. W. Montague & Co. (Rhodes)	4738	1267		
Steel pipe manufacture, machinery used in (Rhodes)	4742–4743	1268		
Steel pipe, maximum pressure of (Rhodes)	4738	1267		
Steel pipe, method of determining average power consumption in making (Rhodes)	4741	1268		
Steel pipe, specifications for, very rigid (Rhodes)	4738	1267		
Steel pipe was made by W. W. Montague Co. (Rhodes)	4737	1267		
Summarization of specifications for steel pipe (Rhodes)	4739	1267		
MOOREHEAD McLEAN IRON WORKS				
Total tonnage and age of iron plates made by for Spring Valley Water Co. (Hazen)			4310	1143
MORING, LEWIS				
Wild Horse Dam No. 2 (Vallejo, Cal.) built by (Noyes)	5261	1421		
MULHOLLAND, MR.				
Dockweiler obtained records of riveted pipe from	4671	1251		
Pipe in schedule furnished by, fabricated under specifications (Dockweiler)	4685	1254		
NEW BEDFORD				
Coating on riveted pipe (Hazen)			4543	1215
Job similar to crossing a channel (Metcalf)			4847	1298
Pipe, condition of, five year tests (Metcalf)			4544	1215
Pipe, inspection of (Metcalf)			4544	1215
Pipe, much more tuberculated and pitted than Spring Valley pipe (Metcalf)			4578	1227
Steel pipe line dipped with asphalt (Hazen)			4545	1215
Submerged pipe job, cost of (Metcalf)			4847	1298
Pipe, tests made on steel line (Metcalf)			4544	1215
Pipe, tuberculation of (Metcalf)			4544	1215
NEW ERA GRADERS				
At Pilarcitos or San Andres, could not be used (Dillman)	5280			
Can only be used where soil is suitable (Noyes)	5277	1426		
Capacity, compared with steam shovel (Noyes)	5293	1429		
Capacity of (Dillman)	5288	1428		
Cost of (Noyes)	5279	1426		
Cost of operating, etc. (Dillman)	5292	1429		
Could be used in borrow pits below Pilarcitos and San Andres (Dillman)	5281	1427		

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NEW ERA GRADERS—Continued.				
Could be used where there are boulders (Dillman)	5283	1427		
Description of (Noyes)	5274	1425		
Dillman knows of several small dams where used	5278	1426		
Efficiency of (Dillman)	5292	1429		
General discussion	5274–5284	1425–1427		
Less expensive method (Dillman)	5282	1427		
Noyes never knew of their use before building of Wild Horse Dam No. 2 (Vallejo, Cal.)	5275	1426		
Oakdale Irrigation District used them (Dillman)	5278	1426		
Operating cost (Dillman)	5292	1429		
Steam shovel costs 5c a yd. more to handle material (Dillman)	5288	1428		
	5291–5294	1429		
39,000 cu. yds. by grader in 61 days (Metcalf)			5310	
Used on levees in Kern County (Noyes)	5284	1427		
Will handle more material (Dillman)	5291	1429		
NEW ENGLAND TRUST CO.				
Dillman made report to, on La Mesa Dam (Dillman)	5012	1347		
NEW JERSEY TUBE CO.				
Quotations on submerged pipe (Hazen)			4773	1277
NEW RIVER FLUME, IMPERIAL VALLEY				
Cost of (Herrmann)			5365	1446
NILES				
Alameda 36" line connects Niles Screen House with Alameda Aqueduct (Hazen)			4685	1254
Sunol-Crystal Springs Dam, estimated cost (Lippincott)			5526	1498
NILES CONE				
Sand for Crystal Springs Dam could be obtained from (Lippincott)			5475	1483
NORTH BEACH, SAN FRANCISCO				
Sand for Crystal Springs Dam obtained from (Dockweiler)	5474	1482		
NOYES, A. P.				
Direct examination (Dams)	5260–5273	1421–1425		
Cross-examination (Dams)	5274–5286	1425–1428		
Re-direct examination (Dams)	5287	1428		
Capacity of New Era Graders and steam shovel compared	5293	1429		
New Era Graders can only be used where soil is suitable	5277	1426		
New Era Graders, capacity of, compared with steam shovel	5293	1429		
New Era Graders, cost of	5279	1426		
New Era Graders, description of	5274	1425		

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NOYES, A. P.—Continued.				
New Era Graders, first knew of their use on dams at Wild Horse Dam No. 2 (Vallejo, Cal.)	5275	1426		
New Era Graders used on levees	5284	1427		
Qualifications	5260	1421		
Rip-rap, Wild Horse Dam No. 2 (Vallejo, Cal.) laid in gravel	5271	1425		
Steam shovel, capacity of, compared with New Era Grader	5293	1429		
Steam shovel not used on Wild Horse Dam No. 2 (Vallejo, Cal.)	5262	1422		
Terms of contract, Wild Horse Dam No. 2 (Vallejo, Calif.)	5268	1424		
Wild Horse Dam No. 2 (Vallejo, Cal.) borrow pits, description of	5274	1425		
Wild Horse Dam No. 2 (Vallejo, Cal.) brush, character of	5269	1424		
Wild Horse Dam No. 2 (Vallejo, Cal.) built by Lewis Moring	5261	1421		
Wild Horse Dam No. 2 (Vallejo, Cal.) built when construction was cheap	5285	1427		
Wild Horse Dam No. 2 (Vallejo, Cal.) clearing contract price	5269	1424		
Wild Horse Dam No. 2 (Vallejo, Cal.) clearing cost	5269	1424		
Wild Horse Dam No. 2 (Vallejo, Cal.) contract price	5267	1423		
Wild Horse Dam No. 2 (Vallejo, Cal.) contract terms of	5268	1424		
Wild Horse Dam No. 2 (Vallejo, Cal.) contractor's profit on	5267	1423		
Wild Horse Dam No. 2 (Vallejo, Cal.) cost account verified by contractors	5266	1423		
Wild Horse Dam No. 2 (Vallejo, Cal.) description of	5261	1421		
Wild Horse Dam No. 2 (Vallejo, Cal.) difficulties in construction	5270	1424		
Wild Horse Dam No. 2 (Vallejo, Cal.) dimensions of	5261	1421		
Wild Horse Dam No. 2 (Vallejo, Cal.) embankment cost	5268	1424		
Wild Horse Dam No. 2 (Vallejo, Cal.) excavation cost	5269	1424		
Wild Horse Dam No. 2 (Vallejo, Cal.) had no core wall	5261	1421		
Wild Horse Dam No. 2 (Vallejo, Cal.) labor cost	5271	1425		
Wild Horse Dam No. 2 (Vallejo, Cal.) length of haul from	5270	1424		

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NOYES, A. P.—Continued.				
Wild Horse Dam No. 2 (Vallejo, Cal.) material, character of	5262	1421		
Wild Horse Dam No. 2 (Vallejo, Cal.) method of construction	5262	1421		
Wild Horse Dam No. 2 (Vallejo, Cal.) no leakage	5265	1423		
Wild Horse Dam No. 2 (Vallejo, Cal.) rip-rap, character of	5268	1424		
Wild Horse Dam No. 2 (Vallejo, Cal.) rip-rap, cost	5273	1425		
Wild Horse Dam No. 2 (Vallejo, Cal.) rip-rap, laid in gravel	5271	1425		
Wild Horse Dam No. 2 (Vallejo, Cal.) settlement in	5265	1423		
Wild Horse Dam No. 2 (Vallejo, Cal.) specifications, extracts from	5263–5265	1422–1423		
	5270	1425		
Wild Horse Dam No. 2 (Vallejo, Cal.) steam shovel not used on	5262	1422		
Wild Horse Dam No. 2 (Vallejo, Cal.) stock owned by contractor	5285	1427		
	5267	1423		
Wild Horse Dam No. 2 (Vallejo, Cal.) yardage of	5261	1421		
OAKDALE IRRIGATION DISTRICT				
Evidence on date of contract for pipe rejected by court	4734	1267		
Figures on cost work of pipe obtained from purchasing agent (Dillman)	4730	1266		
Gravity line, contract date (Dillman)	4734	1267		
Gravity line, Dillman doesn't know if was riveted like Spring Valley Pleasanton line	4732	1266		
Gravity line, equal to Pleasanton Pipe Line of Spring Valley in duty (Dillman)	4731	1266		
Gravity line, no inspection on, other than field inspection (Dillman)	4731	1266		
Gravity line, under-riveted for high pressure (Dillman)	4731	1266		
Gravity line was 34" pipe (Dillman)	4731	1266		
New Era Graders used on (Dillman)	5278	1426		
OGDENSBURG, N. Y.				
Labor, cost of (Hazen)			5446	1474
Material, cost of (Hazen)			5446	1474
OLIVER STEEL CO.				
Memorandum relating to manufacture of iron plates between 1880 and 1890 (Hazen)			4807	1286
Schussler specifications (Hazen)			4806	1206

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OLIVER IRON WORKS, PITTSBURG				
Total tonnage and average age of iron plates made by for Spring Valley Water Co. (Hazen)			4310	1143
ORO GRANDE, CAL.				
Cement can be manufactured for 68c a bbl. (Dockweiler)	5429	1468		
Cement, cost of 68c a bbl. does not include selling cost (Dockweiler)	5430	1468		
O'ROURKE ESTATE				
Real estate sale allowed in evidence. Ruling in favor of City			4159	
OTTAWA, CANADA				
Contract price of steel pipe f.o.b. 7½c lb			4338	1153
Cost of riveted pipe f.o.b. Ottawa (Hazen)			4495	1202
Estimated and built riveted pipe line at (Hazen)			4376	1168
History of Ottawa job (Hazen)			4496	1202
Job not closely comparable to Spring Valley price (Hazen)			4495–4496	1202
Pipe purchase was an emergency order (Hazen)			4496	1202
OVERHEAD				
Accessories not included in (Hazen)			4566	1222
Assumed on other jobs (Lippincott)			5494	1489
Contingencies, explanation of (Hazen)			5511	1494
Crystal Springs, allowances (Lippincott)			5503–5504	1491–149
Crystal Springs Dam, estimate of (Hazen)			5510	1494
Crystal Springs Dam, general remarks (Lippincott)			5487	1487
Crystal Springs Dam, segregation of (Lippincott)			5503	1491
Dorward explains addition of 10%	4903–4905	1312		
Earth dams, employers' liability insurance (Dockweiler)	5047	1357		
Earth dams, exploration not included (Hazen)			4993	
(Herrmann)			4993	
Expense, items included (Lippincott)			5494	1489
			5502	1491
50% added to Spring Valley riveted pipe, covers items which are a small part of the 50% (Dorward)	4917	1315		
Francis Smith Co.'s shop overhead on Spring Valley riveted pipe (Moebus)	4934	1320		
Gibraltar Dam, indirect expense (Lippincott)			5493	1489
Government Dam, inactive accounts on (Lippincott)			5492	1489
Indirect charges on Los Angeles Aqueduct explained (Herrmann)			5112–5114	1376
Items making up 38.85% on Los Angeles Aqueduct classed as indirect charges (Herrmann)			5111–5112	1375–137
Los Angeles Aqueduct (Herrmann)			4981	1337

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OVERHEAD—Continued.				
Los Angeles Aqueduct, administrative expense not charged against the work (Lippincott)			5506	1493
Los Angeles Aqueduct auxiliary expense, items in (Lippincott)			5488	1387
Los Angeles Aqueduct costs, method of keeping (Lippincott)			5488	1487
Los Angeles Aqueduct, roads and trails, items (Lippincott)			5489	1488
Not included in Drum Forebay costs (Herrmann)			5133	1382
Not included in estimate on Pilarcitos Dam (Herrmann)			5116	1377
Office overhead should be added to indirect charges on Los Angeles Aqueduct (Herrmann)			5112	1376
On San Andres pipe line, Hazen 28.8%, Dillman 15½% (Dillman)			4381	1169
Power dams, expense on (Lippincott)			5493	1489
Risdon Iron Works added 50% to cost (Dorward)	4893	1310		
Risdon Iron Works adds 10% for handling riveted pipe and 50% for labor (Dorward)	4901	1311		
Risdon Iron Works did not add 10% for material where Spring Valley paid for plates (Dorward)	4903	1312		
Risdon Iron Works does not include shop profit in 50% overhead on riveted pipe (Dorward)	4902	1311		
Statistics from different works, difficult to compare (Hazen)			5508	1493
Teaming part of original cost to which 10% was added by Risdon Iron Works (Dorward)	4905	1312		
10% overhead to run Francis Smith Co. shop (Moebus)	4936–4937	1320–1321		
Weights, Dockweiler allowed 3% to carry overhead	4441	1187		
PACIFIC GAS & ELECTRIC CO.				
Drum Forebay, cost of (Herrmann)			4969	1333
Drum Forebay, cost of embankment (Herrmann)			5130	1381
Drum Forebay, cost of labor (Herrmann)			5130	1381
Drum Forebay, dimensions (Herrmann)			5126	1380
Drum Forebay, location of (Herrmann)			5126	1380
Drum Forebay, method of construction (Herrmann)			5127	1380
Lake Arthur Dam, cost of (Herrmann)			4970	1333
Lake Valley Dam, cost of (Herrmann)			4970	1333
PAINTING				
Wages for painting joints on riveted pipe (Lawrence)			5331	1437
PANAMA CANAL				
Price of steel dropped because of opening (Dillman)	4676	1252		

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PARK LINE				
Cost of (Hazen)			4393	1172
Cost not comparable to other Spring Valley work (Hazen)			4394	1173
Cost was .087c per lb. (Dockweiler)	4524	1210		
Not comparable, would make percentage of cost higher (Hazen)			4366	1164
Pipe fabricated in San Francisco (Hazen)			4523	1210
Schaw-Batcher contract price 87c a ft. (Hazen)			4536	1213
Specifications called for field test of 200 lbs. per sq. inch (Dockweiler)	4525	1210		
Under-riveted and coating does not compare with Spring Valley standard (Metcalf)			4524	1210
PATENTS				
For pipe making discussed (Hazen)			4518–4519	1209
PAVEMENT				
Cost of cutting and replacing on entire Spring Valley System of riveted pipe lines (Hazen)			4372	1167
Theory, cutting and replacing of pavements is part of reproduction costs (Dockweiler)	4868	1303		
PAYMENTS				
Modesto District, work partly paid for in bonds (Herrmann)			5142	1385
PAYROLLS				
Reference to S. P. labor payrolls (Hazen)			5089	1369
PEEKSKILL, N. Y.				
Labor, cost of (Hazen)			5445	1473
Material, cost of (Hazen)			5445	1473
PENINSULA DAMS				
Labor, wage schedule used in estimating (Herrmann)			4973	1334
PEOPLES WATER CO.				
Dockweiler got data on steam shovel work, Central Reservoir, Oakland, from	5039	1355		
Estimates made for re-financing by (Hazen)			4489	1200
PERCENTAGES				
Added to cost of wrought iron riveted pipe to cover accessories (Hazen)			4308	1143
PENINSULAR LAND				
Real estate sale, Husing to Bourn			4283	1136
Values stipulated in re percentage reduction in value of lands to 1909 (Olney)			4161	
PHOTOGRAPHS				
Los Angeles Aqueduct described (Elliott)			5392	1455
PILARCITOS DAM				
As fine as any in the country (Herrmann)			4990	1341
Benching (Herrmann)			5136	1383
Borrow pits, discussion in re Ebright's information as to location			5400	

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	Record	Abstract	Record	Abstract
PILARCITOS DAM—Continued.				
Borrow pits, information as to location furnished by Ebright, keeper	5399	1458		
Borrow pits, location of (Dockweiler)	5054	1360		
Borrow pits, location of and extent of fall (Dockweiler)	5197	1401		
Borrow pits, location of did not influence Ellis' figures	5237	1414		
Borrow pits near (Dockweiler)	5053	1359		
Calvin Brown report, extract from (Searls)	5253	1319		
Climate and location would increase price of work as compared with Drum Forebay (Herrmann)			5133	1382
Climate compared to Imperial Valley (Herrmann)			4971	1333
Construction compared with Borden Brook Dam, (Springfield, Mass.) (Hazen)			5083	1367
Construction different from Calaveras Dam (Hazen)			5109	1375
Construction, general remarks (Hazen)			4945	1322
Construction, Los Angeles Aqueduct Dams not comparable (Herrmann)			5114-5115	1376–1377
Construction, methods assumed (Hazen)			5109	1375
Construction, proposed method (Elliott)			5390	1454
Construction, would be built differently than Calaveras Dam (Hazen)			5109	1375
Contract on, discussed by Dockweiler	5104	1373		
Contractor's profit allowed by (Ellis)	5253	1419		
Cost, estimates comparable to Drum Forebay (Herrmann)			5133	1382
Cost, total estimate (Hazen)			4949	1324
Cost, units same as San Mateo Creek Dams (Hazen)			4956	1328
Date of construction (Herrmann)			4990	1341
Detailed unit costs of (Ellis)	5232	1412		
Difference between Dockweiler's and Hazen's unit cost applied to San Andres Dam	5066	1363		
	5068	1363		
Dillmann spent less than 10 hours in examination	5169	1393		
Embankments, class of material used (Hazen)			5086	1368
Embankments, comparable to Drum Forebay (Herrmann)			5130	1381
			5136	1383
Embankments, estimated cost of (Ellis)	5231	1412		
Embankments, estimated cost of per cu. yd. (Hazen)			4948	1324
Estimated cost of (Herrmann)			4973	1334
Estimated unit costs (Hazen)			4948	1324
Estimate was based on experience (Hazen)			4945	1322

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	Record	Abstract	Record	Abstract
PILARCITOS DAM—Continued.				
Examination of by Ellis	5230	1411		
Examination of district by Ellis	5236	1414		
Exploration expense not included in estimate (Herrmann)			5117	1378
Exploration work not shown in inventory (Greene)			4992	1341
Labor cost, etc., assumed (Hazen)			5089	1369
Labor figured on 9-hour day (Dockweiler)	5207	1404		
Labor percentage of cost (Herrmann)			5144	1385
Labor, wages figured on (Ellis)	5233	1413		
Lagging, cost of (Dillman)	5156	1389		
Lake Arthur Dam not as high (Herrmann)			5139	1384
Leaks were in the rock and had nothing to do with dam (Herrmann)			4991	1341
Material, cost of placing with steam shovel less than with scrapers (Ellis)	5235	1413		
Material, selection of (Dillman)	5158	1390		
Materials that could be used in reproduction (Elliott)			5398	1457
Material would have to come within range of 1000 or 1200 ft. (Ellis)	5237	1414		
New Era Graders could be used in borrow pits below dam (Dillman)	5281	1427		
New Era Graders could not be use on (Dillman)	5280			
Original cost not considered in 1913 estimate (Hazen)			5111	1375
Overhead not included in estimate (Herrmann)			5116	1377
Powder, not much could be used (Dillman)	5171	1394		
Puddle core, weight per cu. yd. of (Dillman)	5160	1391		
Puddle trench, unit prices for concrete in (Dockweiler)	5057	1316		
Puddling (Herrmann)			4983–4984	1338–1339
Puddling and distance of haul (Dockweiler)	5056	1361		
Puddling, difference in costs between, and San Andres Dam (Dockweiler)	5070	1364		
Puddling, method of (Dillman)	5159	1390		
Puddling, unit costs (Hazen)			4956	1328
Puddling, unit prices for (Dockweiler)	5056	1361		
Quantities (Hazen)			4949	1324
Quantities, stripping embankment, etc. (Herrmann)			4975	1335
Reproduction of by economical methods (Hazen)			5403	
Reproduction, proposed method of (Ellis)	5232	1412		
Reproduction would take two years (Hazen)			5083	1367
Rip-rap, average thickness of (Hazen)			5455	1476
Rip-rap, cost of (Dockweiler)	5058	1361		
Rip-rap, does not know where it was obtained (Herrmann)			5359	1444

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	Record	Abstract	Record	Abstract
PILARCITOS DAM—Continued.				
Rip-rap, examination of (Hazen)			4952	1326
Rip-rap, general remarks (Noyes)	5272	1425		
Rip-rap, hauling and placing, Dockweiler's cost	5058	1361		
Rip-rap, location of quarries (Dockweiler)	5058	1361		
Rip-rap, not as good as at San Andres (Herrmann)			4987	
Rip-rap quarrying, Dockweiler's cost	5058	1361		
Rip-rap, suitable material more available on Modesto work than at Pilarcitos or San Andres (Herrmann)			5359	1444
Roads and trails (Herrmann)			5117	1378
Scrapers, would build with (Elliott)			5397	1457
Settled less, than Tabeaud Dam (Ellis)	5241	1415		
Settling of (Ellis)	5241	1415		
Settling, quotations from Schussler report	5178	1396		
Steam shovel assumed in reproduction (Hazen)			4949–4950	1324–1325
Steam shovel, capacity of, assumed by Dockweiler)	5208	1404		
Steam shovel, cost to ship into (Dockweiler)	5130			
Steam shovel could be taken over existing roads (Dockweiler)	5047	1357		
Steam shovel could not be taken into Pilarcitos on existing roads (Herrmann)			5046	1357
Steam shovel could not be used for reproduction (Elliott)			5398	1457
Steam shovel could not segregate material economically (Elliott)			5396	1457
Steam shovel could work there advantageously (Dockweiler)	5197	1401		
Steam shovel, detail of transporting to (Dockweiler)	5047	1357		
Steam shovel, Dillman assumed capacity of	5171	1394		
Steam shovel, Dockweiler made allowance of 10% for layoffs	5042	1356		
Steam shovel, material in vicinity could be handled very comfortably with (Dillman)	5170	1393		
Steam shovel, method of getting in (Dillman)	5180	1396		
(Dockweiler)	5187	1398		
Steam shovel, output of (Dockweiler)	5042	1356		
Steam shovel, type of, assumed by Dockweiler	5186	1398		
Steam shovel, work at, compared with Calaveras (Elliott)			5397	1475
Steam shovel, work conditions not comparable to San Fernando and Franklin Dams (Elliott)			5389–5390	1454
Steam shovel work conditions are favorable for (Dillman)	5014	1348		
Steam shovel work, estimate of delays on (Dockweiler)	5204	1403		

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PILARCITOS DAM—Continued.				
Steam shovel would be very expensive to get in (Herrmann)			5129	1381
Stripping, cost of (Herrmann)			5122–5123	1379
Stripping, estimate of cost (Hazen)			4949	1324
(Ellis)	5232	1412		
Stripping, method of estimating cost (Herrmann)			5124–5125	1379–1380
Stripping, unit costs (Herrmann)			4965–4966	1331
Teams during delays and layoffs, would not pay for (Dockweiler)	5205	1403		
Timbering, cost of (Dillman)	5156	1389		
Trench construction, Dillman would use a derrick	5173	1394		
Trench, depth of, not important to know in estimating (Dillman)	5166	1392		
Trench, Dillman assumed he would not encounter any hard rock	5173	1394		
Trench work, unit costs (Hazen)			4951	1325
Trench work very expensive (Hazen)			4951–4952	1325–1326
Trenching, character of materials shown by inspection below Pilarcitos (Dockweiler)	5052			
Trenching, difference in cost between San Andres Dam and (Hazen)			5068–5069	1363–1364
Twelve-inch layers used on (Searls)	5244	1416		
Type of structure estimated on by Dillman	5175	1395		
Unit costs (Herrmann)			4976–4977	1335–1336
Unit costs of, compared to San Andres Dam (Dockweiler)	5066	1363		
Unit costs, same as San Andres (Herrmann)			4963	1330
Units, difference between San Andres and Pilarcitos (Dillman)	5026	1351		
Wages for labor figured on by Ellis	5233	1413		
Was not important for Dillman's estimate to know depth of trench	5166	1392		
Water supply (Herrmann)			5115–5116	1377
PILARCITOS OLD DAM				
Out of use, and not considered by Hazen			4956	1328
PILARCITOS PIPE LINE				
Relaid pipe was put in at same price per foot as new pipe (Hazen)			4377	1168
Relaid pipe worth as much as new pipe (Hazen)			4377	1168
Riveted pipe, amount and date laid (Hazen)			4305	1141
Roads included in Spring Valley estimate, on syphon work (Hazen)			4560	1220
PILARCITOS RESERVOIR				
Clearing costs 15% more than Calaveras Sunol Road (Herrmann)			4965	1331
Discussion of (Herrmann)			5120	1379
Purpose of (Herrmann)			5121	1379
Stripping, unit costs (Herrmann)			4965–4966	1331

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PINE CANYON PIPE LINE				
Fabrication cost of could not be segregated for different thicknesses of steel (Hazen)			4553	1218
PIPE				
See (Pipe Riveted)				
Plates, Steel, W. I., etc. } See (Pipe Riveted)				
PIPE, DRAIN				
Earth dams, discussion of			5061	1362
PIPE, IRON				
15% of all used in U. S. is made of puddled iron (Hazen)			4321	1148
Costs about same as steel pipe to fabricate (Dockweiler)	4219	1118		
PIPE LINES				
(See line in question)				
PIPE, PLATES				
See (Pipe Riveted)				
PIPE-PLATE IRON				
How manufactured (Dockweiler)	4220	1118		
PIPE, RIVETED				
Accessories and contingencies in distribution system add 10% cost of excavation (Hazen)			4356	1161
Accessories bear no relation to overhead allowance (Hazen)			4365	1164
Accessories, cost of on Alameda 36" pipe line (Lawrence)			4404	1176
Accessories, cost of, San Andres 44" pipe line (Lawrence)			4403	1176
Accessories figured on a percentage basis (Hazen)			4566	1222
Accessories, items include (Lawrence)			4403	1176
Accessories not included in overhead (Hazen)			4566	1222
Accessories on Albany line about 10% of cost (Hazen)			4362	1163
Accessories on steel pipe line at Washington, D. C., much higher than 10% (Hazen)			4362–4363	1163
Adams memoranda and original figures received from, on Contra Costa job (Dillman)	4727	1266		
Akron, O., contract price delivery at trench caulking and riveting (Hazen)			4338	1153
Akron, O., cost of 3900 feet 5/16" 36" pipe (Hazen)			4512	1207
Akron, O., details of (Hazen)			4503–4504	1205
Akron, O., job comparable to Spring Valley (Hazen)			4504	1205

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PIPE, RIVETED—Continued.				
Alameda line, Belmont to Millbrae, unit prices (Dillman)	4426	1183		
Alameda line, cost of (Hazen)			4341	1155
Alameda line, 54″ line bought by gauge (Hazen)			4308	1142
Alameda line, 54″ line cost and estimate (Hazen)			4567	1223
Alameda line, 54″ line most expensive line Spring Valley has done in recent years (Hazen)			4567	1223
Alameda line, Niles to Dumbarton, unit prices (Dillman)	4425	1182		
Alameda line, Ravenswood to Belmont unit prices (Dillman)	4426	1183		
Alameda line, 36″ line connects screen house with Alameda aqueduct (Hazen)			4685	1254
Allan Wood, iron quotations 25% higher for iron than for steel manufactured (Dillman)	4806	1286		
Analysis of, cost by (Lawrence)			4396	1174
Appraisal, did not make any detailed estimate of the wrought iron pipe on Spring Valley system (Metcalf)			4578	1227
Appraisal, Dillman did not get any quotations on	4688	1256		
Appraisal, Hazen's estimate comports with Metcalf's views (Metcalf)			4580–4581	1227–1228
Argonaut pipe line, excavation cost 38.4c a yard (Ellis)	4886	1308		
Auxiliaries cost of Spring Valley system (Hazen)			4341	1155
Backfill, has not figured how much a man could do in a day (Lawrence)			5350	1442
Backfill, methods used in tamping Spring Valley pipe (Lawrence)			5352	1442
Backfill, practice is to have two tampers and one shoveler (Hazen)			5352	1442
Backfill, unit costs (Lawrence)			5349	1441
Baker Iron Works, figures higher than Lacy Bros. (Dockweiler)	4622	1239		
Baker Iron Works, prices include dipping of pipe (Dockweiler)	4638	1243		
Baker Iron Works, prices 24% higher than Lacy Bros. on that one weight of iron (Dockweiler)	4638			
Baker Iron Works, quotations from letter compared with Dockweiler prices	4668	1256		
Baker Iron Works quotes steel prices at 3.7c per lb. f.o.b. Los Angeles (Dockweiler)	4639	1243		
Basis of cost, used by Hazen			4492	1201
Bends and manholes, always classed as part of pipe (Hazen)			4500	1204
Bends and manholes, cost of at Portland, Ore. (Hazen)			4341	1155

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PIPE, RIVETED—Continued.				
Bends and manholes, not auxilaries always kept separate (Hazen)			4504	1205
Bends, Alameda pipe line, cost of (Hazen)			4341	1155
Bends, cost of (Dockweiler)	4656	1248		
Bends, Dorward's figures do not include	4928	1319		
Bids for 30" steel pipe 5/16" for Los Angeles (Dockweiler)	4454	1191		
Bids from Risdon Iron & Locomotive Works for 44" pipe $3.425 per foot or .0283 per lb. (Dockweiler)	4471	1195		
Bids from Schaw-Batcher on 44" pipe $1.65 per foot, .0136 per lb. (Dockweiler)	4471	1195		
Bid from Union Iron Works on 44" pipe $4.35 per foot or .036 per lb. (Dockweiler)	4471	1195		
Bids obtained from minutes of Spring Valley Water Co. (Dockweiler)	4656	1248		
	4470	1195		
Bids on meters for Hayward job (Dillman)	4482	1198		
Bids received by City of Sacramento for riveted steel and cast iron pipe, etc. (Dockweiler)	4473	1196		
	4475	1197		
Bids, Reitter-Connolly Co. on San Diego pipe (Dockweiler)	4798	1284		
Bids sometimes run above preliminary estimates when based on specifications (Hazen)			4567	1223
Birmingham or the U. S. gauge, used by Dockweiler	4428	1183		
Bloom iron, definition of (Dockweiler)	4639	1243		
Bloom iron, description of (Dockweiler)	4656	1248		
Board for laborers figured at 71c a day in 1903 (Lawrence)			5339	1439
Boiler-makers, reduction in wages in 1913 was an error (Lawrence)			5344	1441
Boston, details of 1911 job (Hazen)			4510	1207
Bought to weight 8 to 10% less pipe than if bought to gauge (Hazen)			4529	1212
Brooklyn, N. Y., costs (Hazen)			4364–4365	1164
Bull Run pipe line, Portland, Ore., details of job (Hazen)			4507-4508	1206
Buying, safer and better way is by gauge (Dockweiler)	4608	1235		
Buying, would specify gauge (Dockweiler)	4609	1235		
Camps usually maintained for construction men on large jobs (Lawrence)			5317	1435
Capacity of Spring Valley pipe system (Hazen)			4314–4315	1144–1145
Capacity of old wrought iron lines of Spring Valley greater than steel pipe of same age (Hazen)			4367	1165
Carpenters, wages of (Lawrence)			5306–5308	1432–1433

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PIPE, RIVETED—Continued.				
Carpenter work on San Andres pipe line explained (Lawrence)			5303	1432
Cartage and freight (Dockweiler)	4656	1248		
Caulker, wages of (Dockweiler)	4645	1245		
Caulking, bevelling not done unless specified (Dockweiler)	4610	1235		
Caulking, cost of (Dockweiler)	4644	1245		
Caulking, data on (Dockweiler)	4643	1245		
Caulking, Dockweiler, observed cost of Risdon Iron Works	4640	1244		
Caulking, Dockweiler obtained data from Hewson in Montague shop	4644	1245		
Caulking, Dockweiler obtained data from Francis Smith yard	4645	1245		
Caulking, equipment for field work would cost not more than $2500	4646	1246		
Caulking, inside is more important than caulking outside (Dillman)	4714	1263		
Caulking, inside not done on light weight pipe iron, as ¼" (Dockweiler)	4641	1244		
Caulking, methods used on Pacific Coast (Hazen)			4350	1158
Caulking, methods used on Pacific Coast cannot be taken as a standard of cost without inspection (Hazen)			4350	1158
Caulking, never heard of running bran through pipes to make caulking tight (Hazen)			4761	1273
Caulking, process of (Dockweiler)	4647	1246		
Caulking split, would not allow (Dockweiler)	4619	1238		
Caulking steel pipe, method of, for Monterey Water Co. (Rhodes)	4751	1270		
Caulking, two kinds, ordinary and split (Dockweiler)	4619	1238		
Charcoal iron, cost of for Alameda pipe line 5½c per lb. (Hazen)			4354	1160
Charcoal iron, method of manufacture (Hazen)			4320–4321	1147–1148
Chenery St. line might have been pipe Moebus referred to as having been laid by Francis Smith Co.			5019	1349
Chenery St. line, not much pressure (Herrmann)			5020	1349
Chipping, is cutting the plate (Dockweiler)	4640	1244		
Chipping methods used (Dockweiler)	4640	1244		
Coating, coal tar mixed with asphalt in Spring Valley dip resulted in an excellent mixture (Hazen)			4546	1216
Coating, cost of			4651–4655	1247–1248
Coating cost .008c per lb (Lawrence)			4398	1174
Coating, life and condition of Spring Valley pipes, due to (Dillman)	4415	1179		

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PIPE, RIVETED—Continued.				
Coating, life of pipe depends most on	4414–4415	1179		
Coating of Spring Valley better than Sacramento pipe job (Dockweiler)	4812	1288		
Coating on New Bedford pipe (Hazen)			4543	1215
Coating one part coal tar, three parts asphaltum (Lawrence)			4398	1174
Coating, weight of in Spring Valley System (Hazen)			4333	1152
Comparison, cost per foot of excavation on Portland, Ore., and Spring Valley			4506	1205
Comparison of Hazen and Dockweiler unit prices on riveted pipe in trench	4490–4491	1200		
Compressor hose, Dockweiler does not know how it is made	4648	1246		
Condition, Spring Valley system in splendid condition (Hazen)			4314	1145
Contra Costa Water Co., Dockweiler prepared data on costs obtained from Arthur L. Adams	4679	1253		
Contra Costa Water Co., Dockweiler estimates for backfilling, laying, hauling and distributing are comparable to Mr. Adams' figures	4681	1253		
Contra Costa Water Co., Dockweiler says Mr. Adams' figures are reasonable	4682	1254		
Contra Costa Water Co., Dillman does not know fabrication cost of pipe on line built by him	4687	1255		
Contra Costa Water Co., explanation of Ex. 100m Defendant	4800	1285		
Contra Costa Water Co. line built by Dillman not very good, it leaked	4686	1255		
Contra Costa Water Co. line built by Dillman was not less than 16″	4686	1255		
Contra Costa Water Co. line was fabricated by Risdon Iron Works (Dillman)	4686	1255		
Contra Costa Water Co., trenching and backfilling 45c (Dockweiler)	4801	1285		
Contra Costa Water Co. work, explanation of Adams' notes on cost (Dockweiler)	4800	1285		
Contract date for Oakdale Irrigation District pipe was this year (Dillman)	4734	1267		
Contract of Lacy Bros. with Los Angeles (Dockweiler)	4452	1191		
Contract of Llewellyn Bros. with Los Angeles for 30″ steel pipe 5/16″ (Dockweiler)	4454	1191		
Contract prices in various cities (Hazen)			4337–4340	1153–1154
Corrections in Lawrence's original table of cost of riveted pipe			5297	1430
Corrections in testimony Hazen cost of excavation, Portland, Ore., 1894				1172

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PIPE, RIVETED—Continued.				
Cost, average of pipe for certain line undipped 4c per lb. (Lawrence)			4397	1174
Cost, average of Spring Valley straight pipe (Hazen)			4340–4341	1154–1155
Cost average unit on 63% of Spring Valley system (Hazen)			4491–4492	1200–1201
Cost data, Moebus did not preserve any on Spring Valley work	4931	1319		
Cost data obtained from Spring Valley records (Hazen)			4535	1213
Cost, Dorward's, are without profits on contract	4901	1311		
Cost, Dorward's method of figuring	4894	1310		
Cost figures given by Lawrence represent minimum expenditure			4407	1177
Cost, increase in, would not have been very much between 1907 and 1912 (Moebus)	4934	1320		
Cost, information from which cost was figured (Dorward)	4891	1309		
Cost, information from Francis Smith (Dockweiler)	4631	1241		
Cost, inspectors usually leave out important items in keeping shop costs (Hazen)			4762	1273
Cost, method of estimating (Dockweiler)	4432	1184		
Cost, method of obtaining 1914-1915 (Hazen)			4388	1170
Cost more to fabricate steel than iron (Dillman)	4431	1184		
Cost, never had any actual costs from books of Risdon Iron Works (Dorward)	4892	1310		
	4897	1311		
Cost of cleaning, Dockweiler observed at Risdon Iron Works	4640	1244		
Cost of making Spring Valley 36" pipe, Francis Smith Co. (Moebus)	4934	1320		
Cost of Park line .087c per lb. (Dockweiler)	4524	1210		
Cost of power per month for Monterey Water Co.'s steel pipe (Rhodes)	4742	1268		
Cost, one day at Risdon Iron Works was only information Dockweiler had as to cost	4640	1244		
Cost, original explanation of (Lawrence)			4396	1174
Cost per foot of riveted pipe laid in trench (Hazen)			4490	1200
Cost, principal difference between wrought iron and steel jobs is the cost of metal (Hazen)			4802	
Cost, reason for adding 9.4% to Eastern price to get Spring Valley cost (Hazen)			4533	1213
Cost, reproduction total for Spring Valley riveted pipe lines laid complete (Hazen)			4372	1167
Cost, total for whole Spring Valley system without accessories (Hazen)			4355	1161

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PIPE, RIVETED—Continued.				
Crystal Springs line, Crystal Springs to Millbrae, unit prices (Dillman)	4422	1182		
Crystal Springs line, excavating at 50c per cubic yard (Dillman)	4423	1182		
Detail of prices (Dockweiler)	4437	1186		
Detail of Risdon Iron Works shop work (Dorward)	4907	1313		
Difference in total cost of San Andres pipe line between Hazen and Dillman	4385	1170		
Dillman allowed 1½c per lb. for all work after plates have arrived in San Francisco	4430	1183		
Dillman assumed requirements of specifications not more expensive than necessity requires	4412	1178		
Dillman doesn't know that Oakdale Irrigation District line was riveted like Spring Valley Pleasanton line	4732	1266		
Dillman estimate based on reproduction cost of wrought iron pipe	4415	1179		
Dillman's experience with bids	4481–4482	1197–1198		
Dillman explains how he made and applied his table showing cost of wrought iron pipe	4417	1181		
Dillman had no experience in wrought iron pipe	4690	1256		
Dillman has not heard of any wrought iron pipe being laid in recent years, outside of Spring Valley plant	4415	1179		
Dillman has not read Spring Valley specifications for plates	4485	1199		
Dillman made examination of pipes taken up at San Bruno, Millbrae	4695	1258		
Dillman point of view in appraisal of Spring Valley	4411–4413	1178–1179		
Dillman says he never laid any wrought iron pipe	4413	1179		
Dillman table explained	4417	1181		
Dillman table showing cost of wrought iron pipe	4416	1180		
Dillman table showing weight and cost per lineal foot	4416	1180		
Dillman was told that Allan Wood iron could be delivered for 3½c per lb. in San Francisco	4720	1264		
Dipping, cost of agreed to by Dockweiler and Hazen			4342	1155
Dipping, cost on 30" San Andres line (Lawrence)			4398	1174
Dipping, cost of with Schussler coating has been one times diameter in inches per lineal foot of pipe exclusive of overhead and interest (Lawrence)			4399	1175
Dipping, Dorward's figures do not include	4928	1319		
Dipping, labor costs (Lawrence)			5323–5324	1436

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
PIPE, RIVETED—Continued.				
Dipping, quotations from Carey's testimony in 1904 case (Lawrence)			5323	1436
Dipping, Spring Valley standard has been very good (Hazen)			4342	1155
Dips used in the New Bedford, Albany and Washington lines not as good as Spring Valley dip (Hazen)			4546	1216
Dockweiler assumed that the work would be done by contract	4432	1184		
Dockweiler has had access to the cost records of Spring Valley Water Co.	4432	1184		
Dockweiler used a differential of 1½c a lb. between steel and wrought iron	4452	1191		
Dorward did not add any profit in his tables	4919	1316		
Dorward explains his estimate on Spring Valley pipe	4906–4907	1313		
Dorward says pipe was made to comply with Spring Valley specifications by Ridson Iron Works	4896	1310		
Dove Canyon data no guide on (Hazen)			4501	1204
Duty in Canada, duty on steel very low (Hazen)			4498	1203
East Jersey Pipe Works make more pipe than any concern in U. S. (Hazen)			4499	1203
East Jersey Pipe Co. sells pipe cheaper than other companies (Hazen)			4518	1209
			4549	1217
Eastern Pipe can be manufactured from 10 to 12% cheaper than here (Dorward)	4922	1317		
Errors in Dockweiler's schedule page 5, item 27	5064	1362		
Estimates, Dorward's higher than Hazen's	4929	1319		
Estimates, for contemplated construction for Spring Valley (Hazen)			4514	1208
Estimates made by me in the 90's (Hazen)			4815–4816	
Estimates made for Peoples Water Co., Oakland, for re-financing (Hazen)			4489	1200
Estimates made on Pacific Coast water works plants (Hazen)			4488	1199
Estimates made on Sacramento water supply project for San Francisco (Hazen)			4489	1200
Excavation, Alameda pipe line in 1908, contractor went broke (Lawrence)			5333–5336	1438–1439
Excavation, assumed at 50c a cubic yard for ordinary (Dillman)	4417	1181		
Excavation, average cost estimated at 70c a cubic yard including backfill and excluding paving replacement (Ellis)	4886	1308		
Excavation, Bull Run pipe line, Portland, Ore. (Dockweiler)	4457	1192		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
PIPE, RIVETED—Continued.				
Excavation, considered work would be done by same methods in 1913 (Lawrence)			5312	1433
Excavation, Contra Costa pipe line, Glue factory, San Leandro, less than 50c a cubic yard	4418	1181		
Excavation, cost Alameda line 1888 (Hazen)			4390	1171
Excavation, cost estimate based on hand work (Ellis)	4888	1308		
Excavation, cost examination of State Highway makes Ellis' figure 65c instead of 70c	4888	1309		
Excavation, cost of, in Crocker Tract 15½c a cubic yard, backfill 3.2c (Ellis)	4887	1308		
Excavation, cost of labor (Lawrence)			5332	1438
Excavation, cost of on 54" Alameda line (Hazen)			4391	1171
Excavation, cost on first Bull Run line 1894 comparatively low, second line 17 years later much greater (Hazen)			4509	1206
Excavation, cost on Portland, Ore. (Hazen)			4392	1172
Excavation, cost per cubic yard (Hazen)			4388	1170
Excavation, cost used records of Seattle, Portland and Victoria (Hazen)			4564	1222
Excavation, cost would be about the same as in East (Hazen)			4563	1221
Excavation, Crystal Springs line, 50c per cubic yard (Dillman)	4423	1182		
Excavation, description of work on San Andres 44" line (Lawrence)			5334	1438
Excavation, Dillman let contract for in Stanislaus County at 26c cubic yard	4418	1181		
Excavation, Ellis has not excavated any trenches in roads	4994	1341		
Excavation, estimate of 75c per yard based on his experience (Hazen)			4563	1221
Excavation, extracts from Hazen's testimony			5343	1440
Excavation, for distribution system including backfill 75c per cubic yard (Hazen)			4356	1161
Excavation, grubbing heavy in trench Bull Run pipe line, Portland, Ore. (Dillman)	4508	1206		
Excavation grubbing was not included in cost of, on Bull Run pipe line, Portland, Ore. (Hazen)			4507–4508	1206
Excavation is easier at Sacramento than in and around San Francisco (Hazen)			4574	1225
Excavation livery hire item (Lawrence)			5345	1441
Excavation makes little difference in cost (Hazen)			4383	
Excavation method of arriving at costs (Hazen)			4389–4390	1170–1171
Excavation, no experience with trenching machines (Lawrence)			5312	1434

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PIPE, RIVETED—Continued.				
Excavation of Spring Valley Water Co. examined by Ellis	4886	1308		
Excavation prices on 36″ 5/16″ steel line on Los Angeles (Dockweiler)	4462	1193		
Excavation, quotations from Minute Book "D" re Alameda pipe line (Lawrence)			5333	1438
Excavation San Andres 44″ line, 51c a yard, backfill 20c a yard (Dockweiler)	4436	1185		
Excavation San Andres 44″ line, total cost of (Dockweiler)	4437	1186		
Excavation Spring Valley system cost 70c a cubic yard (Ellis)	4886	1308		
Excavation Sutter Creek syphon cost 47c (Ellis)	4887	1308		
Excavation, total quantity outside of city (Hazen)			4355	1161
Excavation, unit prices for trenching in State Highway (Ellis)	4997	1342		
Excavation, unit prices of Ellis for, compared to Hazen's	4998	1342		
Excavation, wide trenches more expensive than narrow (Ellis)	4995	1341		
Excavation, yardage for different sized pipe in Spring Valley system (Hazen)			4506–4507	1205–1206
Excavation, yardage shown in P 37 was obtained from profiles (Lawrence)			4406	1177
Experience, Dillman never had any in manufacture of pipe	4700	1259		
Experience, none with pipe works in San Francisco (Hazen)			4493	1201
Experience with (Hazen)			4375–4376	1168
Fabrication basis of assumption that wrought iron would cost less than steel (Dillman)	4699	1259		
Fabrication basis of cost (Hazen)			4492	1201
Fabrication cost and wages have not dropped since beginning of European war (Dockweiler)	4675	1252		
Fabrication cost from F. Hewson on 24″ pipe (Dockweiler)	4630	1241		
Fabrication cost from Monterey Water Works (Dockweiler)	4630	1241		
Fabrication cost from various people (Dockweiler)	4630	1241		
Fabrication costs greater if done under proper specifications and supervision (Hazen)			4569	1224
Fabrication cost in Los Angeles higher than in the East (Hazen)			4516	1208
Fabrication cost in San Francisco would be 20% greater than in the East (Hazen)			4993	1201

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PIPE, RIVETED—Continued.				
Fabrication cost of syphons for Los Angeles (Hazen)			4551	1217
Fabrication cost Pine Canyon line could not be segregated for different thicknesses of steel (Hazen)			4553	1218
Fabrication cost would be about $1.30 (Moebus)	4935	1320		
Fabrication, Dockweiler made no difference in the price between steel and wrought iron	4453	1191		
Fabrication, estimate based on what it cost without any correction			4539	1214
Fabrication, great deal of pipe fabricated in Los Angeles did not stand test and inspection of Eastern works (Hazen)			4517	1208
Fabrication, improved methods of would lessen the cost (Rhodes)	4755	1271		
Fabrication, increase of 20% if done in San Francisco based (Hazen)			4514	1208
Fabrication, letter from Lacy Bros. in re of (Dockweiler)	4443	1187		
	4447	1189		
Fabrication, methods of have improved (Rhodes)	4754–4755	1271		
Fabrication, not as efficiently done in East on account of cold (Dockweiler)	4623	1239		
Fabrication, quotations from Western Pipe & Steel Co. (Dockweiler)	4449	1190		
Fabrication, quotations not to be depended upon (Hazen)			4569	1224
Fabrication, reason for increase of 20% if Spring Valley pipe was done in San Francisco (Hazen)			4514	1208
Fabrication, shop labor, Dockweiler doesn't remember that it cost .6 of a cent	4634	1242		
Fabrication, specifications for largest line used by Spring Valley Water Co.	4591	1229		
Fabrication, steel costs more than iron (Dillman)	4431	1184		
Fabrication, too many shops in California (Hazen)			4815	
Francis Smith Co. was open shop (Moebus)	4935	1320		
Freight rates on plates (Hazen)			4329	1150
Generally made to order (Dockweiler)	4590	1229		
Grubbing very heavy in trench excavation on Bull Run pipe line, Portland, Ore. (Dillman)	4508	1206		
Hauling, big riveted pipe expensive (Hazen)			4489	1200
Hauling, cost Antelope syphon plant (Hazen)			4557	1219
Hauling, estimated on a basis of $5 per ton (Hazen)			4490	1200

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
PIPE, RIVETED—Continued.				
Hauling, increase from $3.90 per ton to $5 per ton due to higher cost of labor and teams (Hazen)			4490	1200
Hauling, Spring Valley records show $3.90 per ton as far as they go (Hazen)			4490	1200
Hours of work were reduced 20% which would make the total increased cost of labor 32% (Dorward)	4917	1315		
If you pay a cheap price you get a poor pipe (Dorward)	4926	1318		
In re Dorward's table showing cost of fabricating and laying original Spring Valley pipes by Risdon Iron Works	4891	1309		
	4899	1311		
Inspection, Dillman has no faith in, of steel in Eastern mills	4693	1257		
Inspection, Dillman would require, in laying pipe	4694	1257		
Inspection, Dockweiler believed in reasonable	4596	1232		
Inspection, Dockweiler would require proper, in specifications	4598	1232		
Inspection, "finicky" (Dockweiler)	4599	1232		
Inspection, independent not allowed in steel mills (Dillman)	4483	1198		
Inspection, in mill customary and essential in purchase of pipe (Hazen)			4570	1224
Inspection, inspector should be on job all time (Dockweiler)	4596	1232		
Inspection, it is proper to have wrought iron inspected (Dillman)	4693	1257		
Inspection, memorandum relating to manufacture of iron plates between 1880 and 1890 (Hazen)			4807	1286
Inspection, might add to cost (Dillman)	4694	1257		
Inspection, not mentioned when getting prices from Lacy Bros. (Dockweiler)	4615	1237		
Inspection, of armor plates for Government at Harrisburg (Dillman)	4484–4485	1198–1199		
Inspection, of plates at mill (Hazen)			4547	1216
Inspection, practice in manufacture of Spring Valley plates not known by Dillman	4485	1199		
Inspection, specifications should require proper (Dockweiler)	4596	1232		
Inspection, Spring Valley Water Co. maintained inspectors at will during manufacture of plates (Hazen)			4321	1148
Inspection, would not make additional expense (Dockweiler)	4599	1232		
Iron, amount of and date laid in Pilarcitos line (Hazen)			4305	1141

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	Record	Abstract	Record	Abstract
PIPE, RIVETED—Continued.				
Iron, dipped, price 36", ¼" $6.08 per lineal foot (Dockweiler)	4668	1251		
Iron, does not corrode and tuberculate as rapidly as steel pipe, instance cited (Hazen)			4316	1145
Iron, in Spring Valley pipes best obtainable (Hazen)			4322	1148
Iron, more desirable than steel (Hazen)			4316–4317	1145–1146
Iron, pipe replaced with steel would cost substantially more (Hazen)			4370	1166
Joints, methods used in making (Hazen)			4359	1162
Kettles, rental of was in addition to Risdon contract price (Dorward)	4910	1314		
Labor, acquired familiarity with conditions on Pacific Coast by observation and inquiry			4488	1199
Labor, California conditions compared with Eastern (Hazen)			4568	1223
Labor, comparisons made by City Engineer of Boston (Metcalf)			4576	1226
Labor, cost fabricated pipe .6 of a cent per pound (Dockweiler)	4648	1247		
Labor, costs have increased since laying of most of Spring Valley pipe (Hazen)			4346	1156
Labor, costs here would not be 20% greater than in the East (Dorward)	4922	1317		
Labor, costs kept separately (Lawrence)			4400	
Labor, cost not much increase from 1900 to 1912 (Moebus)	4935	1320		
Labor, cost on steel pipe for Monterey Water Co. (Rhodes)	4750	1270		
Labor, Dockweiler visited Risdon Iron Works to get cost of	4634	1242		
Labor, Dorward knew wages of men employed at Risdon Iron Works	4893	1310		
Labor, efficiency not as high as 10 years ago (Dorward)	4929	1319		
Labor, efficiency of (Lawrence)			5319	1435
Labor, 8 hour day is observed in San Mateo County and 9 hours in Alameda County (Lawrence)			4409	1178
Labor, Ellis familiar with price of in San Francisco bay section	4886	1308		
Labor, experience with (Lawrence)			5299	1431
Labor, explanation of column 5, Exhibit 100 (Dockweiler)	4729	1266		
Labor, explanation of items on 54" Alameda pipe (Lawrence)			5337	1439

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	Record	Abstract	Record	Abstract
PIPE, RIVETED—Continued.				
Labor, foreign and cheap labor is not used in fabricating pipe in Eastern pipe works (Hazen)			4493	1201
Labor, for pipe manufacturing could not be obtained on Pacific Coast (Hazen)			4520	1209
Labor, Hazen made inquiries in San Francisco concerning conditions of			4568	1223
			4574	1225
Labor, Hazen obtained information from the Southern Pacific payrolls			4568	1223
Labor, is more efficient on the Pacific Coast than in the East (Hazen)			4575	1226
Labor, is 20% more efficient here than in East (Dockweiler)	4624	1240		
Labor, Lawrence assumed 8 hour day in reproduction of whole Spring Valley system			5344	1441
Labor, men worked 10 hour day up to 1902 (Dorward)	4893	1310		
Labor, not as efficient now as in the old days (Dorward)	4918	1316		
Labor, obtained information from Mr. Riffle (Dockweiler)	4632	1242		
Labor, price of labor does not control the manufacture of pipe (Hazen)			4518	1209
Labor, union rate in San Mateo County for common labor $2.50 per day (Lawrence)			4408	1177
Labor, wages have been the same since 1903 (Lawrence)			5338	
Labor, Wages of carpenters (Lawrence)			5328	1437
Labor, wages of foreman (Lawrence)			5327	1436
			5336	1439
			5343	1440
Labor, Western Steel & Pipe Co. work 9 hour day; Schaw-Batcher 8 hour; pay same ratio (Dockweiler)	4625	1240		
Labor, would organize in San Mateo County on large jobs (Lawrence)			5322	1435
Laborers not used in lagging trenches (Lawrence)			5305	1432
Laborers, wages of (Lawrence)			5306–5308	1432–1433
Lacy Bros. bid on San Diego pipe (Dockweiler)	4798	1284		
Lacy Bros., Dockweiler told them he was making appraisal for City of San Francisco	4613	1236		
Lacy Bros., fabrication assumed to be within 60 miles of San Francisco (Dockweiler)	4626	1240		
Lacy Bros., letter from in re weights riveted pipe (Dockweiler)	4447	1189		

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
PIPE, RIVETED—Continued.				
Lacy Bros., no provision for caulking inside and out	4618	1238		
Laying, analysis of cost (Dockweiler)	4659	1249		
Laying, comparison of Dockweiler's costs and costs in Schaw-Batcher Co.'s letter for 44" pipe (Dockweiler)	4663	1249		
Laying, cost of joining and laying 36", 37" and 44" pipe (Dockweiler)	4650	1247		
Laying, costs were not part of Risdon shop work (Dorward)	4911	1314		
Laying, Schaw-Batcher letter quoting prices (Dockweiler)	4653	1248		
Life lasting qualities of wrought iron compared with steel (Hazen)			4573	1225
Llewellyn Iron Works bid on San Diego pipe (Dockweiler)	4798	1284		
Los Angeles Aqueduct auxiliary expense (Hazen)			4559	1220
Los Angeles Aqueduct contract price for delivery at trench, caulking and riveting (Hazen)			4338	1153
Los Angeles Aqueduct costs not to be taken as basis in this case (Metcalf)			4583	1229
Los Angeles Aqueduct cost of Antelope Syphon (Hazen)			4550	1217
Los Angeles Aqueduct cost of ¼" syphon (Hazen)			4502	1204
Los Angeles Aqueduct data furnished by Mr. Mulholland (Hazen)			4500	1204
Los Angeles Aqueduct, data furnished by Mulholland up to 5/16" plates used (Hazen)			4502	1204
Los Angeles Aqueduct, details of work (Hazen)			4502	1204
Los Angeles Aqueduct, Dove Canyon, details of work (Hazen)			4500–4501	1204
Los Angeles Aqueduct, indirect costs of pipe were very great (Hazen)			4558	1219
Los Angeles Aqueduct, no contract price for pipe fabricated and delivered (Hazen)			4561	1220
Los Angeles Aqueduct, notes on cost of syphons (Hazen)			4549	1217
Los Angeles Aqueduct, weight records, Antelope syphon not correct (Metcalf)			4553	1218
Los Angeles Aqueduct, work on not comparable to Spring Valley work (Hazen)			4555	1218
Los Angeles cost records, copies by J. G. White Co. (Dockweiler)	4585	1229		
Los Angeles pipe bought to weight (Hazen)			4528	1211

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	Record	Abstract	Record	Abstract
PIPE, RIVETED—Continued.				
Los Angeles pipe in schedule furnished by Mulholland, fabricated under specifications (Dockweiler)	4685	1254		
Los Angeles, prepared plans and specifications for pipe work in (Dockweiler)	4590	1229		
Los Angeles records of purchase obtained from Mulholland (Dockweiler)	4671	1251		
Los Angeles syphon pipe not dipped, but painted (Hazen)			4555	1218
Lumber for P. P. I. E. was not all purchased by John Hooper (Dillman)	4486	1199		
Made by best factories not as well riveted as Spring Valley pipes (Dillman)	4713	1263		
Made in California inferior in metal and workmanship, and not comparable to Spring Valley pipe (Hazen)			4348	1157
Manufacture cheaper in Los Angeles than in San Francisco at present time (Hazen)			4348	1157
Manufacture, cost of all Spring Valley pipes (Hazen)			4344	1156
Manufacture, method of, for Spring Valley by Risdon Iron Works (Dorward)	4923	1317		
	4925	1316		
Manufactured in East and shipped to San Francisco would result in economy (Hazen)			4347	1157
Manufacturing cost estimated separately from plates (Hazen)			4334	1152
Manufacturing cost in San Francisco much higher at present time than when Spring Valley was made (Hazen)			4346	
Manufacturing, total cost of, 1914-15 (Hazen)			4387	1170
Market conditions since 1907 (Hazen)			4817	1290
Merced and Pleasanton lines, no specifications for (Hazen)			4522	1209
Metal, cost of, in San Andres pipe line (Hazen)			4341	1155
Method of expanding from 10-hour day to 8-hour (Lawrence)			5301–5302	1431
Minneapolis, cost of 54" and 48" riveted pipe (Hazen)			4510	1207
Minneapolis 48" and 54" riveted pipe used as comparison for estimating Spring Valley pipe (Hazen)			4511	1207
Moebus, builder of pipe lines for Spring Valley	4930	1319		
Moebus don't know the location of Spring Valley pipe made by Francies Smith Co.	4931	1319		
Moebus familiar with Francis Smith shop costs.	4930	1319		
Monterey Water Co., cost of power per month (Rhodes)	4742	1268		

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PIPE, RIVETED—Continued.				
Monterey Water Co., cost of work Dockweiler knew	4736			
New Bedford, Albany and Washington steel pipe lines dipped with asphalt (Hazen)			4545	1215
New Bedford line, conditions of in 5-year tests (Metcalf)			4544	1215
New Bedford line, inspection of (Metcalf)			4544	1215
New Bedford pipe much more tuberculated and pitted than Spring Valley pipe (Metcalf)			4578	1227
New Bedford pipe tubercles on (Metcalf)			4544	1215
Oakdale Irrigation Dist., contract for pipe let 1915 (Dillman)	4734	1267		
Oakdale Irrigation Dist., gravity lines about equal to Pleasanton line of Spring Valley in duty (Dillman)	4731	1266		
Oakdale Irrigation Dist. gravity line 34" pipe (Dillman)	4731	1266		
Oakdale Irrigation Dist. gravity line under-riveted for high pressure (Dillman)	4731	1266		
Oakdale Irrigation Dist., no inspection on gravity line other than field inspection (Dillman)	4731	1266		
Oakdale Irrigation Dist., pipe rejected by Court (Dillman)	4734	1267		
Ottawa job, cost of (Hazen)			4495	1202
Ottawa job, description of (Hazen)			4496	1202
Ottawa job not comparable to Spring Valley price (Hazen)			4495	1202
Ottawa line, estimated and built by Hazen			4376	1168
Ottawa pipe was an emergency order (Hazen)			4496	1202
Overhead, Dillman's cost includes Structure 11, page 21, San Andres Pipe Line	4380	1169		
Overhead, Dockweiler allowed 3% to carry	4441	1187		
Overhead, Dockweiler's total cost on Structure 11, page 21, San Andres not included	4380	1169		
Overhead, 50% covers items which are a small part of the 50% (Dorward)	4917	1315		
Overhead, Francis Smith Co.'s shop on Spring Valley pipe 10% (Moebus)	4934	1320		
Overhead on Structure 11, page 21, San Andres Pipe Line, Hazen's 28.8%, Dillman's 15½% (Dillman)	4381	1169		
Overhead, 10% explained by Dorward	4903–4905	1312		
Overhead, 10% profit was added by Francis Smith Co. (Moebus)	4937	1321		
Overhead, 10% to run Francis Smith Co.'s shop (Moebus)	4936–4937	1320–1321		
P. P. I. E. made by Schaw-Batcher was weighed after dipping and paid for by weight (Rhodes)	4756	1272		

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PIPE, RIVETED—Continued.				
Park line, cost of (Dockweiler)	4524	1210		
Park line, cost of (Hazen)			4393	1172
Park line costs not comparable to other work (Hazen)			4394	1173
Park line fabricated in San Francisco (Hazen)			4523	1210
Park line is under-riveted and coating does not compare with Spring Valley standard (Metcalf)			4524	1210
Park line not comparable, would make percentage of cost higher if used (Hazen)			4366	1164
Patents for pipe making discussed (Hazen)			4518–4519	1209
Pavement, cost of cutting and replacing Spring Valley system (Hazen)			4372	1167
Percentages added to cover accessories (Hazen)			4308	1143
Pilarcitos, relaid pipe put in at same price per foot as new pipe (Hazen)			4528	1211
Pilarcitos, relaid pipe worth as much as new pipe (Hazen)			4377	1168
Pipe of Spring Valley Water Co. bought to weight (Hazen)			4528	1211
Pipe, total number of tons now in service in main pipe lines (Hazen)			4306	1141
Pipe work, cost of, Oakdale Irrigation Dist., obtained from purchasing agent (Dillman)	4730	1266		
Plates, cost and manufacture figured separately (Hazen)			4334	1152
Plates, charcoal iron, total tonnage and age, made by Central Iron & Steel Co. for Spring Valley Water Co. (Hazen)			4310	1143
Plates, iron, total tonnage and age, made by Allan Wood Co. for Spring Valley Water Co. (Hazen)			4310	1143
Plates, iron, total tonnage and age, made by Morehead & McLean Co. (Hazen)			4310	1143
Plates, iron, total tonnage and age, made by Oliver Iron Works, Pittsburg, for Spring Valley Water Co. (Hazen)			4310	1143
Plates, of Victoria, B. C., line not comparable to Spring Valley plates (Hazen)			4513	1207
Plates, puddled iron, total tonnage and age, made by Central Iron & Steel Co., for Spring Valley Water Co. (Hazen)			4310	1143
Plates, Scotch iron, total tonnage and age, made by Thornycroft Iron Works, Scotland, for Spring Valley Water Co. (Hazen)			4310	1143
Plates, specifications for, not read by Dillman	4485	1199		
Plates, steel and wrought iron, method of buying and selling (Hazen)			4307–4308	1142

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
PIPE, RIVETED—Continued.				
Plates, thickness of plates for riveted pipe (Hazen)			4368	1165
Plates, wrought iron, price of 4c per lb. f. o. b., San Francisco, agreed to by Hazen and Dockweiler			4325	1149
Pleasanton Line, allowed less for best Spring Valley pipe than for this line (Dockweiler)	4607	1235		
Pleasanton Line, applied standard Spring Valley price to this job, which is too much (Dockweiler)	4605	1234		
Pleasanton Line, contract price known by Dockweiler)	4605	1234		
Pleasanton Line, discussion as to making and laying (Moebus)	4939	1321		
Pleasanton Line, Dockweiler never examined to see if it was under-riveted	4601	1233		
Pleasanton Line, estimated at $2.82 per lineal foot (Dockweiler)	4604	1234		
Pleasanton Line, excavation in inventory (Hazen)			5342	1440
Pleasanton Line, excavation on (Lawrence)			5341	1440
Pleasanton Line, fair example of work done by Francis Smith Co. (Moebus)	4940	1321		
Pleasanton Line, figures not expanded to 8-hour day for 1913 (Lawrence)			5344	1441
Pleasanton Line, has served purpose for which it was built (Lawrence)			5340	1440
Pleasanton Line, Moebus doesn't remember job.	4938	1320		
Pleasanton Line, never examined to see if it was under-riveted (Dockweiler)	4601	1233		
Pleasanton Line, not comparable to other pipes in Spring Valley system (Dockweiler)	4603	1234		
Pleasanton Line, not fabricated to the Spring Valley standard (Dockweiler)	4603	1234		
Pleasanton Line, prices, estimated detail of (Dockweiler)	4604	1234		
Pleasanton Line, would not build pipe like it to stand pressure (Dockweiler)	4601	1233		
Portland, Maine, 48" line built by Hazen			4376	1168
Portland, Oregon, contract price for delivery of pipe at trench, caulking and riveting (Hazen)			4338	1153
Portland, Oregon, 1909 details of work (Hazen)			4509	1206
Portland, Oregon, work not comparable to Spring Valley (Hazen)			4341	1155
Portland pipe bought to gage (Hazen)			4528	1211
Power consumption, method of determining average, Monterey Water Co. (Rhodes)	4741	1268		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
PIPE, RIVETED—Continued.				
Pressure tests on San Diego pipe (Dockweiler)..	4795	1283		
Price, average for all iron in system (Hazen)...			4313	1144
Price, detail of (Dockweiler).....	4437	1186		
Price, Dillman does not keep track of market...	4688	1256		
Price, Dockweiler agrees to price of 4c per lb. f.o.b. San Francisco for iron (Hazen).....			4325	1149
Price, dull times makes no difference in the prices of material (Hazen).....			4815	1289
Pipe, 54" pipe dipped, $9.61 per foot (Dockweiler)	4668	1251		
Price, 40" line laid in Los Angeles (Dockweiler)	4461	1192		
Price, method of estimating (Hazen).....			4377–4378	1168–1169
Price, of 5c at trench is taken from memory (Dillman)	4429	1183		
Price of, from East Jersey Pipe Co. for Portland, Oregon, job (Hazen).....			4494	1202
Price of, have quotations covering back as far as 1884 (Dockweiler)	4223	1119		
Price of lumber P. P. I. E. $11 per thousand including drayage (Dillman).....	4483	1198		
Price of pipe made from thick plates not applicable to pipe made of thin plates (Hazen)..			4351	1159
Price of steel and wrought iron pipe f.o.b. San Francisco compared (Hazen).....			4802	1285
Price of steel has been low since European war (Dockweiler)	4675	1252		
Price of steel for 1914 was lower than 1913 on an average (Dillman).....4723–4724		1265		
Price on steel obtained from "Iron Age" (Dillman)	4719	1264		
Price per pound for finished pipe without accessories (Hazen)			4352	1152
Price quoted for pipe made in California is sometimes low (Hazen).....			4348	1157
Price quotations for puddled iron f.o.b. San Francisco (Hazen)			4327–4329	1149–1150
Price paid for charcoal iron f.o.b San Francisco (Hazen)			4326	1149
Price steel higher today than in 1913 (Dillman)	4675	1252		
	4678	1253		
Price steel dropped because of Panama Canal opening (Dillman)	4676	1252		
Price W. I. plate cost 70% more than steel (Hazen)			4802	1285
Price year 1907 was one of very high prices (Hazen)			4816	

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	Record	Abstract	Record	Abstract
PIPE, RIVETED—Continued.				
Profit at present time 30% or 35%, ten or fifteen years ago profits were from 50 to 60% (Dorward)	4919	1316		
Profit on, would run from 15 to 25% between 1907 and 1912 (Moebus)	4934	1320		
Profit up to 1910 were good (Dorward)	4921	1316		
Profit was added to 10% overhead by Francis Smith Co. (Moebus)	4937	1321		
Profit were reduced in 1910 (Dorward)	4921	1316		
Puddle iron, method of manufacture (Hazen)			4317	1146
			4320	1147
Puddled iron of extra quality, for riveted pipe in Spring Valley system 4c per pound (Hazen)			4353	1160
Puddled iron, ordinary, for riveted pipe in Spring Valley system 3½c per lb. f.o.b San Francisco (Hazen)			4354	1160
Quantities, in Spring Valley system (Hazen)			4304	1141
Quotations are cut in bids (Dillman)	4482	1198		
Quotations, Baker Iron Works letter to Dockweiler	4638	1243		
	4667	1250		
Quotations, Dockweiler did not get any from Eastern pipe houses	4622	1239		
Quotations from dealers will be cut when you buy (Dillman)	4430	1183		
Quotations from "Iron Age" were on steel plates, less than ¼" (Dillman)	4721	1264		
Quotations from manufacturers mean nothing (Hazen)			4519	1209
Quotations from Western Pipe & Steel Co. (Dockweiler)	4469	1195		
Quotations generally by lineal foot (Dillman)	4689	1256		
Quotations on good and poor pipe (Dorward)	4927	1318		
Quotations on steel for 1913-14-15 (Dillman)	4719	1264		
Quotations usually higher than bids (Dockweiler)	4478	1197		
Records of labor and material (Lawrence)			4410	1178
Records of work in steel cannot be used without modification in estimates for wrought iron (Hazen)			4351	1159
Records Spring Valley, person not familiar with work, could work up original cost from (Lawrence)			5326	1436
Records of Spring Valley are for partial cost only (Lawrence)			5327	1436
Records Spring Valley, description of, at Millbrae (Lawrence)			5344	1441
Reitter-Connolly Mfg. Co. bid on San Diego pipe (Dockweiler)	4798	1284		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
PIPE, RIVETED—Continued.				
Re-laid pipe, number of tons in system (Hazen)			4306	1141
Re-laid pipe, summary showing location of (Hazen)			4311	1143
Reproduction cost based on mechanical improvements (Hazen)			4347	1157
Reproduction cost estimated by Dorward as of Dec. 31, 1913	4917	1315		
Reproduction cost in 1913, 30 to 35% should be added to Risdon figures for (Dorward)	4921	1316		
Rhodes doesn't know anything of Schaw-Batcher's shop cost on P. P. I. E. pipe	4755	1271		
Rhodes inspected pipe for P. P. I. E. in Schaw-Batcher Works	4755	1271		
Risdon Iron Works added 50% to cost for overhead (Dorward)	4893	1310		
Risdon Iron Works adds a profit on top of the 10 and 50% overhead (Dorward)	4902	1311		
Risdon Iron Works adds 10% overhead for handling and 50% for labor (Dorward)	4901	1311		
Risdon Iron Works details of works (Dorward)	4909	1314		
Risdon Iron Works did not add 10% for material where Spring Valley paid for plates (Dorward)	4903	1312		
Risdon Iron Works does not include shop's profit in 50% overhead (Dorward)	4902	1311		
Risdon Iron Works estimated costs as of Dec. 1913 (Dorward)	4920	1316		
Risdon Iron Works fabrication, method of (Dorward)	4907	1313		
Risdon Iron Works made very good pipe for Spring Valley Water Co. (Hazen)			4525	1210
Risdon Iron Works shop labor, etc., on Spring Valley pipe (Dorward)	4914–4915	1315		
Risdon Iron Works time keeper reported directly to office on laying of Spring Valley riveted pipe (Dorward)	4911	1314		
Riveting and caulking in trench ¼" plate, Portland, Ore., costs (Hazen)			4495	1202
Riveting and caulking on pipe, sample of Spring Valley explained by (Hazen)			4358–4361	1162–1163
Riveting, big house would do same kind with or without specifications (Dockweiler)	4592	1230		
Riveting, cost of (Hazen)			4803	1285
Riveting, cost of, Dillman does not care to go into detail	4431	1184		
Riveting, Dillman did not figure on Spring Valley riveting	4698	1259		
Riveting, Dillman did not use boilermakers' standard	4697	1258		

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	Record	Abstract	Record	Abstract
PIPE, RIVETED—Continued.				
Riveting, if properly done, is quite an item in cost (Hazen)			4803	1285
Riveting, methods adopted by Dockweiler	4591	1229		
Riveting, method used (Hazen)			4311–4312	1144
Riveting, most of Spring Valley pipe was made as well as any pipe Dillman knows of	4713	1263		
Riveting necessary to develop full strength of pipe (Hazen)			4349	1157
Riveting, shop cost, details of (Dockweiler)	4627	1240		
Riveting, strength of joint never equal to strength of pipe (Dillman)	4712	1263		
Rivets, average cost of .0688c (Lawrence)			4397	1174
Roads included in Spring Valley estimate of syphon on Pilarcitos work (Hazen)			4560	1220
Road work, items charged for (Lawrence)			5331	1437
Rochester, N. Y., condition of wrought iron and steel pipe lines at (Hazen)			4546	1216
Sacramento, cost of different sized pipe (Dockweiler)	4814	1288		
Samples of Spring Valley pipe explained by Hazen			4358–4361	1162–1163
San Andres line, amount and date laid (Hazen)			4305	1141
San Andres line, bought by gage (Hazen)			4308	1142
San Andres line, compared with Dockweiler's and Dillman's estimate (Hazen)			4380	1169
San Andres line, Dillman has not figured total weight of line (Dillman)	4422	1182		
San Andres line, extras amount to $2795 (Dillman)	4420	1182		
San Andres line, 44" x ¼", cheapest work Spring Valley ever did (Hazen)			4567	1223
San Andres line, 44" x ¼", cost and estimate (Hazen)			4567	1223
San Andres line, item 2-unit prices (Dillman)	4384	1169		
San Andres line, total $278,653, or $9.20 per foot (Dillman)	4420	1182		
San Andres line, unit prices (Dillman)	4419	1181		
San Andres line, wrought iron pipe, cost of (Hazen)			4378	1169
San Diego, record of bids submitted to city (Dockweiler)	4671	1251		
San Diego, specifications not onerous (Dockweiler)	4796	1284		
Schaw-Batcher contract price on Park Line 87c per foot (Hazen)			4536	1213
Schaw-Batcher Co., letter from, to Spring Valley Water Co. (Dockweiler)	4653	1248		
Schaw-Batcher Co., letter to Dockweiler	4470	1195		

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
PIPE, RIVETED—Continued.				
Schussler said Francis Smith Co.'s work was good (Moebus)	4941	1321		
Seattle figures not comparable to this case (Hazen)			4517	1208
Seventh Ave. Tunnel has nothing to do with riveted pipe line (Hazen)			4372	1167
Sheet-iron, methods of making (Dockweiler)	4220	1118		
Shop costs about same in 1900 as in 1912 (Moebus)	4936	1320		
Shop costs, how obtained (Hazen)			4763	1273
Shop work and work in trench, cost per lb. for straight pipe (Hazen)			4538	1213
Shop work, Risdon Iron Works, detail of (Dorward)	4907	1313		
Slip joint, costs reduced 1c per lb. (Hazen)			4353	1160
Slip joint, explanation (Hazen)			4312	1144
Specifications, Dillman never read Schussler's for wrought iron plates (Dillman)	4691	1257		
Specifications, Dockweiler would require bevelling and shearing	4610	1235		
Specifications, Dorward did not pay attention to, in making up cost	4895	1310		
Specifications, Dorward was familiar with Spring Valley specifications for laying and fabricating	4895	1310		
Specifications, for Monterey Water Co. steel pipe very rigid (Rhodes)	4738	1267		
Specifications for Park Line called for 200 lbs. per sq. in. for field test (Dockweiler)	4525	1210		
Specifications of Schussler, Oliver Steel Co. (Hazen)			4806	1286
Specifications on which San Diego bids were based (Dockweiler)	4672	1252		
Specifications on Sacramento job not unusual (Dockweiler)	4813	1288		
Specifications Sacramento job (Dockweiler)	4810			
	4814			
Specifications, Schussler's were good (Hazen)			4572	1225
Specifications, Spring Valley were very rigid (Hazen)			4571	1224
Specifications, summarization of, for steel pipe, Monterey Water Co. (Rhodes)	4739	1267		
Specifications, summarization of, on San Diego job (Dockweiler)	4794	1283		
Specifications 268, Los Angeles, were drawn on a weight basis (Dockweiler)	4610	1235		
Specifications, what they contain (Dockweiler)	4590	1229		
Specifications, what they should contain (Hazen)			4571	1224

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	Record	Abstract	Record	Abstract
PIPE, RIVETED—Continued.				
Spring line, Mass., built by Hazen			4376	1168
Springfield summary, showing cost of 32" line built by Hazen supporting 10% addition to excavation for accessories			4362	1163
Spring Valley bought to weight, except in two important cases (Hazen)			4532	1212
Spring Valley coating is the best in U. S. (Dockweiler)	4527	1211		
Spring Valley coating several times thicker than is put on in any other part of U. S. (Dockweiler)	4527	1211		
Spring Valley paid good price for pipe made by Risdon Iron Works (Dorward)	4925	1318		
Spring Valley pipe make by Risdon Iron Works was first-class (Dorward)	4925	1318		
Spring Valley sent their own inspector to Risdon Iron Works (Dorward)	4924	1317		
Stanislaus work, excavation cheaper than on Spring Valley (Dillman)	4687	1255		
Stanislaus work, excavation done by trenching machine (Dillmann)	4687	1255		
Steel and iron pipe cost about the same to fabricate (Dockweiler)	4219	1118		
Steel, average price for, Metcalf table			4721–4722	1264–1265
Steel, average price on in 1914 was below 1½c on tank plates (Metcalf)			4720	1264
Steel, best steel 1913 would be almost as durable as wrought iron with same kind of coating (Dillman)	4714	1263		
Steel, carrying capacity of Spring Valley system (Hazen)			4314–4315	1144–1145
Steel cheaper than iron (Dockweiler)	4221½	1119		
Steel contracts are taken by mills under various specifications and same steel furnished to fill all (Dillman)	4484	1198		
Steel, contract price f.o.b. Ottawa, Canada, 7½c per pound (Hazen)			4338	1153
Steel, contract price 3.51c per lb. f.o.b. Portland, Oregon (Hazen)			4337	1153
Steel corrodes and tuberculates more rapidly than iron (Hazen)			4316	1145
Steel, cost of in Spring Valley system 2¼c per lb. f.o.b. San Francisco (Hazen)			4354	1160
Steel, cost of manufacturing (Hazen)			4335–4336	1152–1153
Steel difficult to get tight (Rhodes)	4750	1270		
Steel for Monterey Water Co., machinery used in the manufacture of (Rhodes)	4742–4743	1268		

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	Record	Abstract	Record	Abstract
PIPE, RIVETED—Continued.				
Steel for Monterey Water Co. required hydraulic pressure of 175 lbs. per sq. in. before dipping (Rhodes)	4739	1267		
Steel for Monterey Water Co. was made by W. W. Montague & Co. (Rhodes)	4737	1267		
Steel is being used because it is cheaper, stronger, and can be obtained in larger plates (Hazen)			4371	1166
Steel, manufacture of, for Monterey Water Co., general remarks (Rhodes)	4749	1270		
Steel, method of buying and selling plates (Hazen)			4307–4308	1142
Steel, method of manufacturing (Hazen)			4348–4349	1157
Steel not as desirable as iron (Hazen)			4316–4317	1145–1146
Steel, number of tons in Spring Valley system (Hazen)			4306	1141
Steel pipe corrodes and early lines will disappear in time (Hazen)			4372	1167
Steel pipe has largely replaced wrought iron for water pipes in U. S. (Hazen)			4366–4367	1164–1165
Steel pipe, maximum pressure of Monterey Water Co. (Rhodes)	4738	1267		
Steel pipe perforations caused by surface defects in the plates (Hazen)			4547	1216
Steel pipe, Rhodes does not know what Monterey Water Co. paid	4750	1270		
Steel pipe, Rhodes got wages paid on, from pay-roll	4752	1271		
Steel pipe, Rhodes inspected for Monterey Water Co.	4737	1267		
Steel pipe, Rhodes kept analysis of	4739	1267		
Steel pipe, when new should have greater carrying capacity than old wrought iron pipe of Spring Valley (Hazen)			4370	1166
Steel pipe would have to be of greater diameter to have same capacity as iron pipe (Hazen)			4367	1165
Steel plates, actual price of for the year 1.42c per lb. at Pittsburg (Hazen)			4337	1153
Steel plates bought to weight are 8 to 10% lighter than plates bought by gage (Hazen)			4528	1211
Steel, price per lb. laid (Hazen)			4331–4332	1151
Steel sheets and tank plates, difference between (Dillman)	4722	1265		
Steel sheets and tank plates, difference in (Hazen)			4722	1265
Steel sheets are manufactured differently from steel plates (Hazen)			4723	1265
Steel will rust faster than iron (Dillman)	4414	1179		

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
PIPE, RIVETED—Continued.				
Steel would not last as long as wrought iron (Hazen)			4574	1225
Structures, special cost on certain Spring Valley lines (Hazen)			4372–4373	1167
Summary of main lines 1914-1915 (Hazen)			4388	1170
Sutter Creek Syphon, excavation cost 47c (Ellis)	4887	1308		
Teaming was part of the original cost to which 10% was added (Dorward)	4905	1312		
Teams were hired by the day (Lawrence)			5314	1434
Tests, all pipe built by me was tested at 300 lbs. and special tested at 1000 lbs. pressure before dipping (Hazen)			4757	1272
Thickness, discussion in re No. 9 iron			4463–4468	1194–1195
Thickness in Spring Valley system averages 35½" diameter and .188" thick (Hazen)			4304	1141
Thickness was determined from the inventory (Dillman)	4428	1183		
Transportation, actual cost of, not known by Dorward	4902	1311		
Transportation, cost on Alameda pipe line, from shop to ditch (Hazen)			4343	1155
Transportation, cost on San Andres pipe line from shop to ditch (Hazen)			4343	1155
Trench, detail of 5c per foot at (Dillman)	4429	1183		
Trenching, familiar with Bull Run pipe Line, Portland, Oregon (Hazen)			4507	1206
Trenching, Hazen used machine in his estimate (Hazen)			4815	1289
Trenching, there is saving in using trenching machine over hand labor (Dockweiler)	4814	1288		
Trestles, cost of carpenters and labor, Baden Screen Tank Trestle (Lawrence)			5330	1437
Trestles, location of on San Andres pipe line (Lawrence)			5329	1437
Trestles, nine between screen tank and Baden (Lawrence)			5331	1437
Under-riveting, meaning of (Dockweiler)	4601	1233		
Unit prices on Structure 11, page 21, San Andres Pipe Line, Hazen, Dockweiler, Dillman (Dillman)	4381	1169		
University Mound Line 44", 37" and 37½" pipe, page 331 of inventory, are part of (Hazen)			4685	1254
Victoria, B. C., plates were fabricated in Canada (Hazen)			4512	1207
Wages, increase of from 1884 to 1913 was 12% (Dorward)	4917	1317		
Wage schedule, not much difference between Los Angeles and San Francisco (Dockweiler)	4455	1192		

	Defendant		Plaintiff	
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PIPE, RIVETED—Continued.				
Washington line built by Hazen			4376	1168
Waste in manufacture (Hazen)			4309	1143
Watchman's time on San Andres pipe line explained by (Lawrence)			5305	1432
Weights, Alameda pipe line taken from Spring Valley records (Lawrence)			5298	1430
Weights, a long ton not used in the riveted pipe business (Hazen)			4530	1212
Weights and cost per lineal foot shown by Dillman's table	4416	1180		
Weights Dillman says if he and Hazen had gotten together they could have agreed on	4710	1262		
Weights, difference between long and short ton would be 12% in the cost (Dillman)	4689	1256		
Weights, Dillman's compared to Hazen's and Dockweiler's	4700	1259		
Weights, Dillman not sure that pipe is sold by the long ton	4689	1256		
Weights, Dillman thinks Hazen's formula is wrong in re thin plates	4701–4706	1260		
Weights, Dillman thinks his chart nearer the truth than Hazen formula	4703	1260		
Weights, discussion of in re comparison of different engineers (Dockweiler)	4439			
Weights 8¼% above Spring Valley estimate (Hazen)			4330	1151
Weights, finished pipe weighs 10% more than metal (Hazen)			4496	1202
Weights, formula for computing weight (Hazen)			4333	1151
Weights, Hazen's formula does not apply to Spring Valley pipes			4527–4527	1121
Weights, Hazen's formula explained by (Dillman)	4708	1261		
Weights, Hazen's formula explained by (Hazen)			4708	1261
Weights, Hazen's formula represents weight of all ordinary steel pipe			4527	1211
Weights, Hazen's formula 13% more than actual Spring Valley weight of metal			4334	1152
Weight, if pipe weight checks Hazen's formula would be right (Dillman)	4708	1261		
Weight is 8 or 10% greater where plates are bought to gauge (Hazen)			4351	1159
Weights, Lawrence weights were used with some modifications (Hazen)			4710	1262
Weights, methods of computing (Dockweiler)	4438	1186		
Weights, methods of obtaining, on Sprnig Valley pipe (Dorward)	4908	1313		
Weight of coating equals 9.4% of metal (Hazen)			4343	1155

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PIPE, RIVETED—Continued.				
Weight of coating runs close to loss of metal in manufacture (Hazen)			4337	1153
Weight of different sizes of pipe as per Lacy Bros. (Dockweiler)	4446	1189		
Weight of different sizes of pipe, San Andres line (Dockweiler)	4437	1186		
Weight of, in system (Hazen)			4333	1152
Weight of pipe, page 15, Hazen's schedule explained (Hazen)			4525–4526	1210
Weight of rivets amount to 4% (Hazen)			4330	1150
Weight of wrought iron 2% lighter than steel (Hazen)			4526	1210
Weight, other information does not agree with Lawrence's weights (Searls)	4817	1290		
Weight possible, that Spring Valley pipes will not measure in weight with Dillman's chart	4704	1260		
Weight, 3% waste in manufacture (Dillman)	4711	1262		
Western Pipe & Steel Co.'s bid on San Diego riveted pipe (Dockweiler)	4797	1284		
Western Pipe & Steel Co. Dockweiler did not submit specifications, when asking for prices	4616	1237		
Western Pipe & Steel Co. knew Dockweiler was making valuation for San Francisco	4616	1237		
Western Pipe & Steel Co. lines built by, for Spring Valley were inferior (Hazen)			4521–4523	1209–1210
Winnipeg job was special pipe (Hazen)			4498	1203
Winnipeg line estimated by (Hazen)			4376	1168
With Dillman prices, he would not consider it a good contract if done with antagonistic supervision	4412	1178		
Wrought iron and steel pipe, difference between (Dillman)	4413	1179		
Wrought iron, cost of manufacturing (Hazen)			4336	1153
Wrought iron, cost shown by Dillman's table	4416	1180		
Wrought iron could not be manufactured on large scale today (Hazen)			4371	1166
Wrought iron, Dillman had no experience in	4690	1256		
Wrought iron, Dillman has not heard of any being laid recently	4415	1179		
Wrought iron, Dillman prefers to steel for pipe	4692	1257		
Wrought iron, general remarks on use and advantage of (Hazen)			4542	1215
Wrought iron has a greater durability than steel pipe (Hazen)			4540	1214
Wrought iron has no advantage over steel as long as the coating is intact (Dillman)	4415	1179		

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	Record	Abstract	Record	Abstract
PIPE, RIVETED—Continued.				
Wrought iron in old Spring Valley lines lasted because of its wonderful resistance to corrosion (Hazen)			4367	1165
Wrought iron is still an important material for small pipe (Hazen)			4540	1214
Wrought iron is wonderful structural material for pipes (Hazen)			4541	1214
Wrought iron is worked easier, especially in punching and caulking (Dillman)	4413	1179		
Wrought iron, method of buying and selling plates (Hazen)			4307–4308	1142
Wrought iron more durable than steel (Dillman)	4692	1257		
	4694	1257		
Wrought iron, none laid by Dillman	4413	1179		
Wrought iron, number of tons in Spring Valley system (Hazen)			4306	1141
Wrought iron pipe is preferable to steel (Hazen)			4371	1166
Wrought iron plates, their small size is a disadvantage (Hazen)			4542	1215
Wrought iron, prices per lb. laid (Hazen)			4332–4333	1151
Wrought iron, quotations from Allan Wood added 25% to cost of steel (Dillman)	4695	1258		
Wrought iron, study of character of metal (Hazen)			4312	1444
PIPE, SAMPLES				
See (Pipe, Riveted)				
PIPE, SLIP JOINT				
Description (Hazen)			4312	1144
See (Pipe, Riveted)				
PIPE, STEEL				
Fabrication costs about same as iron pipe to (Dockweiler)	4219	1118		
Tensile strength is greater than iron (Dockweiler)	4222	1119		
See (Pipe, Riveted)				
PIPE, WROUGHT IRON				
See (Pipe, Riveted)				
PIPE, SUBMERGED				
Barge and tug boat service, Dockweiler's estimated cost	4781	1279		
	4791	1282		
Bull Run pipe, Portland knew of (Dillman)	4825	1291		
Cable, Dockweiler estimated on the use of only one	4793	1283		
Chelsea Creek, method of laying not similar to Spring Valley system (Metcalf)			4847	1298

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PIPE, SUBMERGED—Continued.				
Chelsea Creek would require less equipment than Spring Valley (Metcalf)			4848	1298
Comparison of Hazen and Dockweiler prices			4774	1278
Connecticut River lines and Spring Valley lines, length of (Hazen)			4827	1292
Connecticut River lines cost $39.90 a foot (Hazen)			4828	
Connecticut River lines was steel (Hazen)			4828	
Connecticut River pipe, cost of (Hazen)			4828	1292
Connecticut River pipe was laid differently from Spring Valley pipe (Hazen)			4827	1292
Contingencies, Dockweiler did not allow for	4786	1281		
Contingencies were added to cover Dockweiler's lack of knowledge on details	4878	1305		
Contract for 22", extract from (Dockweiler)	4785	1281		
Contractor's profit would be about $6 a foot more than would ordinarily be allowed (Dockweiler)	4788	1282		
Cost considered in estimating (Hazen)			4760	1272
Cost considered, the Spring Valley cost very low (Hazen)			4831	1293
Cost contingencies were based on Dockweiler's judgment	4878	1305		
Cost, Dillman's formula	4851	1299		
Cost, Dockweiler's estimates compared to actual cost for 16"	4864	1302		
	4866	1303		
Costs, estimated totals (Hazen)			4758	
Costs, figures on pipe laid by (Metcalf)			4841–4848	1296–1298
Costs, if Dockweiler had known an experienced crew had laid it, it would not have affected his estimate	4872	1304		
Costs, in some cases costs of intake pipe are comparable (Metcalf)			4846	1298
Costs, laying intake pipe not applicable to this work (Hazen)			4831	1293
Costs of laying cast iron pipe (Metcalf)			4842	1296
Costs of 16", the Spring Valley records show the old contract price (Hazen)			4771	1276
Costs of 22" Spring Valley line (Hazen)			4770	1276
Costs, reasons why the pipe should cost less after the 16" was laid (Dockweiler)	4867	1303		
Depth would make slight difference in laying of pipe (Dillman)	5007	1346		
Dillman did not go into details in his appraisal	4825	1291		
Dillman has no data on, or much experience	4856	1300		
Dillman's formula for costs would not apply to light pipes	4853	1300		

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PIPE, SUBMERGED—Continued.				
Dillman's information on 24" pipe line at Portland, Ore., does not check his formula	5006	1345		
Dillman never laid any	4850	1299		
Dillman's total estimate	4759	1272		
Dipping, Lawrence says 20 foot lengths in Carey's testimony not true			5324	1436
Dockweiler does not remember if it was flexible jointed pipe in Los Angeles outfall sewer	4858	1301		
Dockweiler has never seen any laid	4860	1301		
Dockweiler laid 1200 feet submarine outfall sewer pipe in Los Angeles	4858	1301		
Dockweiler's total estimate	4759	1272		
Dredging, cost of—Portland, Ore. (Dillman)	4999	1342		
Dredging, cost of—at Ravenswood less than at Portland (Dillman)	5000	1343		
Dumbarton being a longer crossing, would make average cost less (Dillman)	5008	1346		
Estimates of time were based on progress profile (Dockweiler)	4789	1282		
Galvanizing, Dockweiler's cost—not segregated.	4865	1302		
Galvanizing, Hazen's cost			4865	1302
Intakes, work not reliable as index to cost of submarine (Metcalf)			4846	1298
Joints cost—Dockweiler's detailed estimate of	4781	1279		
	4784	1281		
Labor, condition of at Vancouver and San Francisco (Hazen)			4840	1296
Labor, cost of would be greater at present (Hazen)			4770	1276
Labor, segregation of—Portland, Ore. (Dillman)	5000	1343		
Laying—cost—Dillman made no segregation for	4854	1300		
Laying cost of, for 24" line at Portland, Ore. (Hazen)			4768	1275
Laying cost of, for 28" line at Portland (Hazen)			4768	1275
Laying cost of, for 30" line at Portland (Hazen)			4769	1275
Laying cost of, for 30" pipe at Springfield, Mass. (Hazen)			4768	1275
Laying cost of, for 22" pipe Spring Valley system (Hazen)			4767	1274
Laying detailed cost of Spring Valley 16" (Dockweiler)	4776	1278		
Laying difficulties increase as depth of water increased (Hazen)			4828	1292
			4834	
Laying, Dockweiler's total cost	4784	1281		
Laying, estimate of Dockweiler (Dockweiler)	4875	1304		
Laying equipment would cost less under present conditions (Dockweiler)	4872	1304		

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PIPE, SUBMERGED—Continued.				
Laying, Healy & Tibbitts' table showing detailed cost of (Dockweiler)	4782–4783	1279–1280		
Laying, improved method explained (Dockweiler)	4792	1283		
Laying, improvements in, since installation of Spring Valley (Dockweiler)	4792	1283		
Laying is extra hazardous work (Hazen)			4832	1293
Laying, labor costs higher at present time (Dockweiler)	4847	1298		
Laying, total cost (Hazen)			4784	1281
Laying 22"—Dockweiler's detailed estimate for	4791	1282		
Lead and cost per lb. and weight			4780	1278
Lead calculations of Dockweiler correct, but no allowance for loss and waste (Hazen)			4819	1290
Lead, weight of—and cost per lb. (Dockweiler)	4780	1279		
Length—difference between Hazen and Dockweiler			4819	1290
Length 6,300 feet in each line (Hazen)			4862	1302
Lengths, used by Dockweiler were agreed to when inventory was made	4864	1302		
Los Angeles job not comparable to Spring Valley	4859	1301		
Making and laying—methods used (Hazen)			4765–4767	1273–1274
Material cost would be about the same today (Hazen)			4770	1276
Material, estimate of (Dockweiler)	4875	1304		
New Bedford job—cost of (Metcalf)			4847	1298
New Bedford job similar to crossing a channel (Metcalf)			4847	1298
Portland, Ore., condition with respect to interference (Hazen)			4830	1293
Portland, Ore., costs—method of computing (Dillman)	5000	1343		
Portland, Ore., line laid by same method as Spring Valley (Hazen)			4765	1273
Portland, Ore., method of laying (Hazen)			4830	1293
Portland, Ore., unit costs (Hazen)			5004	1345
Portland, Ore., unit costs (Dillman)	4998	1342		
Portland, Ore., water was deep enough for navigation (Dillman)	5007	1345		
Price per pound based on quotations from Crane Co. (Dockweiler)	4773	1277		
Profit contractors should expect more than 20% (Hazen)			4835	1294
Profit, Dillman understood Risdon Iron Works made an enormous profit on Spring Valley job	4826	1291		
Progress of work, remarks (Dockweiler)	4790	1282		
Quotations—Dockweiler got from Healy & Tibbitts on barge and tugboat service	4782	1279		

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PIPE, SUBMERGED—Continued.				
Quotations from New Jersey Tube Co. (Hazen)..			4773	1277
Ravenswood line, basis of Dillman's estimate on	4850	1299		
Ravenswood line—Dillman's estimate on.....	4849–4850	1299		
Ravenswood pipe—Dillman did not see.....	4825	1291		
Ravenswood pipe—examination of (Dillman)...	4853	1300		
Ravenswood pipe in good condition (Dillman)..	4854	1300		
Repairs, none have been made and Spring Valley pipe believed to be perfectly tight (Hazen)..			4770	1276
Size, date laid, etc. (Hazen).....			4765	1273
Specifications—tightness of Spring Valley pipe had to be demonstrated (Hazen).....			4837	1295
Springfield job is the only one comparable to Spring Valley (Hazen).....			4849	1299
Steel, Spring Valley line is built of (Hazen)...			4828	
Storm, conditions less severe at Portland, Ore. (Dillman)	5009	1346		
Superior, Wis., line—Hazen does not know cost (Hazen)			4830	1293
Superior, Wis., line is cast iron pipe (Hazen)...			4829	1292
Superior, Wis., line, method of laying.....			4829	1292
Superior, Wis., supervised laying 24″ line at (Hazen)			4768	1275
Tidal, currents were very strong at Ravenswood (Hazen)			4834	1294
Total estimate on 22″ (Dockweiler).....	4791	1282		
22″ pipe was laid in rush, therefore bid was high (Dockweiler)	4785	1281		
Unit costs detailed (Dockweiler).....	4774–4775	1278		
Unit costs, detail of Spring Valley line (Dockweiler)	4773	1277		
Unit cost on 22″—Dockweiler's detail.....	4791	1282		
Valuation—basis of records of Spring Valley, etc., submerged pipe (Dockweiler).....	4860	1301		
.....	4876	1305		
Value of, estimates of (Dillman).....	4826	1291		
Value of, estimates of (Dockweiler).....	4861	1301		
.....	4878	1305		
Value of, did not get figures on other submerged pipe work (Dockweiler).....	4880	1306		
Vancouver—cost of material (Hazen).....			4838	1295
Vancouver line, cost of (Hazen).....			4769	1275
Vancouver line, depth of water (Hazen).....			4839	1296
Vancouver line, description (Hazen).....			4769	1275
Vancouver line, labor conditions (Hazen).....			4840	1296
Vancouver line, length of pipe (Hazen).....			4838	1295
Vancouver line, method of laying (Hazen).....			4839	1296
Vancouver line, pipe was cast iron (Hazen)....			4838	1295

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PIPE, SUBMERGED—Continued.				
Vancouver line, similar to Spring Valley crossing (Hazen)			4768	1275
Vancouver work comparable to Spring Valley submerged pipe (Hazen)			4760	1272
Weights, difference in Hazen's weight from agreed schedule			4778	1278
Weights, Hazen's formula for computing weight of welded pipe			4771–4772	1276–1277
Weights of bells is more than the amount shown in the agreed schedule (Hazen)			4776	1278
Weights of 16" line (Hazen)			4778	1278
Weights, other information does not agree with Lawrence weights (Searls)	4817	1290		
Weights, records of mill shows weight (Hazen)			4865	1302
Weights used by Dockweiler and method of obtaining	4778–4779	1278–1279		
Wind a little higher at Dumbarton, than at Portland, Ore. (Dillman)	5007	1346		
Winds would cause extra expense at Dumbarton (Dillman)	5010	1346		
PITTSBURG, PENN.				
Steel plates, actual price of for year 1.42c per lb. (Hazen)			4334	1153
PITTSFIELD, MASS., DAM				
Description of (Hazen)			5424	1465
PLATES				
Difference between steel sheets and tank plates (Dillman)	4722	1265		
Difference of 8 or 10% in buying to weight and gauge for riveted pipe (Hazen)			4351	1159
Dillman—doesn't know of practice of inspection in the manufacture of plates of Spring Valley	4485	1199		
Inspection of, at mill (Hazen)			4547	1216
"Iron Age", quotations from—were on steel plates less than ¼" (Dillman)	4721	1264		
Pipe bought to gauge is thinner on edges than in the middle (Hazen)			4531	1212
Pipe riveted, cost of manufacture figured separately (Hazen)			4334	1152
Pipe, Spring Valley bought to weight except in two important cases (Hazen)			4528	1211
			4532	1212
Price 4c per lb. for wrought iron f.o.b. San Francisco agreed to by Hazen and Dockweiler			4325	1149
Prices per lb. for pipe made of thick plates not applicable to pipe made of thin plates (Hazen)			4351	1159
Risdon Iron Works did not add 10% for material where Spring Valley paid for plates (Dorward)	4903	1312		

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PLATES—Continued.				
Specifications, Dillman has not read Spring Valley Water Co.'s	4485	1199		
	4691	1257		
Steel, actual price of for year at Pittsburg 1.42c per lb. (Hazen)			4337	1153
Steel, average price in 1914 was below 1½c on tank plates (Metcalf)			4720	1264
Steel, bought to weight, is 8 to 10% lighter and cheaper than plates bought to gauge (Hazen)			4528	1211
Steel, difference between steel sheets and tank plates (Hazen)			4722	1265
Steel sheets are manufactured differently from steel plates (Hazen)			4723	1265
Steel and wrought iron, method of buying and selling explained (Hazen)			4307–4308	1142
Tonnage and age of, made by Allan Wood Co. for Spring Valley Water Co. (Hazen)			4310	1143
Tonnage and average age, made by Central Iron and Steel Co. for Spring Valley Water Co. (Hazen)			4310	1143
Tonnage and average age of, made by Morehead and McLean, Pitt., for Spring Valley Water Co. (Hazen)			4310	1143
Tonnage and average age, made by Oliver Iron Works, Pitt., for Spring Valley Water Co. (Hazen)			4310	1143
Tonnage and average age, made by Thornycroft Iron Works for Spring Valley Water Co. (Hazen)			4310	1143
Victoria, B. C., pipe fabricated in Canada (Hazen)			4512	1207
Victoria, B. C., scarcely comparable to Spring Valley plates (Hazen)			4513	1207
Wrought iron cost 70% more than steel f.o.b. San Francisco (Hazen)			4802–4803	1285
Wrought iron, memorandum relating to manufacture of between 1880 and 1890 (Hazen)			4807	1286
Wrought iron, small size of, is a disadvantage (Hazen)			4542	1215
See also Pipe Riveted.				
PLEASANTON LANDS				
Discussion in re stipulation as to value			4160	
PLEASANTON PIPE LINE				
Allowed less for best Spring Valley pipe than for this line (Dockweiler)	4607	1235		
Applied Standard Spring Valley price to this job, which is too much (Dockweiler)	4605	1234		
Contract price known (Dockweiler)	4605	1234		

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PLEASANTON PIPE LINE—Continued.				
Cost of, shown on sheet "P 27" Lawrence's Analysis			4405	1176
Detail of estimate (Dockweiler)	4604	1234		
Dillman doesn't know if Oakdale Irrigation District line is riveted like Spring Valley Pleasanton line	4732	1266		
Equal in duty to gravity line of Oakdale Irrigation District (Dillman)	4731	1266		
Estimated at $2.82 per lineal ft. (Dockweiler)	4604	1234		
Excavation in inventory explained (Hazen)			5342	1440
Excavation on (Lawrence)			5341	1440
Fair sample of work done by Francis Smith Co. (Moebus)	4940	1321		
Has served purpose for which it was built (Lawrence)			5340	1440
Labor, figures not expanded to an eight hour day for 1913 (Lawrence)			5344	1441
Making and laying (Moebus)	4939	1321		
Moebus doesn't remember job	4938	1321		
Not comparable to other pipes in Spring Valley System (Dockweiler)	4603	1234		
Not fabricated to the Spring Valley Standard (Dockweiler)	4603	1234		
Pilarcitos relaid pipe estimated at same price per ft. as new pipe (Hazen)			4377	1168
Pipe, has small amount of inferior pipe (Hazen)			4522	1209
Specifications were not furnished by Spring Valley for pipe (Hazen)			4522	1209
Under-riveted—Dockweiler never examined to see	4601	1233		
Would not build pipe like it to stand pressure (Dockweiler)	4601	1233		
PLEASANTON RANCH HOUSES				
Valued at $135,000 (Dockweiler)	4823	1291		
PLUMS				
Crystal Springs Dam, none available (Hazen)			5439	1471
Spaulding Dam—percentage used (Lippincott)			5528	1499
PORTLAND, MAINE				
Sixteen miles of 48" riv. pipe built by (Hazen)			4376	1168
PORTLAND, ORE.				
Accessories, summary showing cost of riveted pipe lines and percentage for accessories (Hazen)			4363–4364	1163–1164
All pipe bought to gauge (Hazen)			4528	1211
Bends and manholes—cost of (Hazen)			4341	1151
Bull Run Pipe Line—details (Hazen)			4507–4508	1206
Contract price for delivery at trench caulking, and riveting pipe (Hazen)			4338	1153

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PORTLAND, ORE.—Continued.				
Contract price of steel pipe 3.51c per lb. f.o.b. Portland, Ore. (Hazen)			4337	1153
Correction in testimony excavation 1894 (Hazen)			4393	1172
Dillman asked to compute cost per ft of Bull Run Pipe Line	4942	1322		
Dredging cost of—at Ravenswood less than at Portland (Dillman)	5000	1343		
Dredging for submerged pipe, cost of (Dillman)	4999	1343		
Excavation comparison of cost per ft on Portland, Ore., and Spring Valley			4506	1205
Excavation, cost for first Bull Run Line, 1894—comparatively low—2nd line 17 years later much greater (Hazen)			4509	1206
Excavation figures from Bull Run Pipe Line (Dockweiler)	4457	1192		
Excavation 1911, cost of (Hazen)			4392	1172
Excavation 1894, cost of (Hazen)			4392	1172
Excavation, grubbing was not included in cost of Bull Run Pipe Line (Hazen)			4507–4508	1206
Grubbing in trench excavation on Bull Run Pipe Line, very heavy (Dillman)	4508	1206		
Laying 24″ submerged pipe line, cost of (Hazen)			4768	1275
Laying 28″ submerged pipe line, cost of (Hazen)			4768	1275
Laying 30″ submerged pipe line, cost of (Hazen)			4769	1275
1909 jobs—details (Hazen)			4509	1206
Pipe riveted—price of from East Jersey Pipe Co. (Hazen)			4494	1202
Riveting and caulking ¼″ plate in trench, cost of (Hazen)			4495	1202
Storm conditions less severe at (Dillman)	5009	1346		
Submerged pipe—conditions with respect to interference (Hazen)			4830	1293
Submerged pipe laid by same method as Spring Valley (Hazen)			4765	1273
Submerged pipe, method of laying (Hazen)			4830	1293
Submerged pipe, unit costs (Dillman)	4998	1342		
Submerged pipe, unit costs (Hazen)			5004	1345
Submerged pipe, water was deep enough for navigation (Dillman)	5007	1346		
Trenching—familiar with character of on Bull Run Pipe Line (Hazen)			4507	1206
Wind a little higher at Dumbarton, than at (Dillman)	5007	1346		
POWDER				
Cost of—per cu. yd. of excavation (Herrmann)			5154	1389
Not much could be used at Pilarcitos Dam (Dillman)	5171	1394		
San Andres Dam not much used at (Dockweiler)	5154	1389		

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POWER				
Cost of stripping at Calaveras (Herrmann).....			5122–5123	1379
Cost of per month for making steel pipe Monterey Water Co. (Rhodes).....	4742	1268		
Method of determining average consumption of, in making steel pipe for Monterey Water Co. (Rhodes)	4741	1268		
Required to drive compressor in the manufacture of steel pipe for Monterey Water Co. (Rhodes)	4753	1271		
POWER PLANT				
Cost of at Calaveras (Herrmann).....			5123	1379
PRESSURE				
Chenery St. riveted pipe—not much pressure on this part of the line (Herrmann).....			5020	1349
Maximum, of Monterey Water Co. steel pipe (Rhodes)	4738	1267		
Pleasanton Line not built to stand much pressure (Dockweiler)	4601	1233		
Specifications for Monterey Water Co. steel pipe required hydraulic pressure of 175 lbs. per sq. in. before dipping (Rhodes).....	4795	1267		
Tests on San Diego riveted pipe (Dockweiler)..	4795	1283		
PRICES				
Akron, O., contract for delivery of pipe at trench, caulking and riveting (Hazen).....			4338	1153
Alameda Line, Belmont to Millbrae, unit prices (Dillman)	4426	1183		
Alameda Line, Niles to Dumbarton, unit prices (Dillman)	4425	1182		
Alameda Line, Ravenswood to Belmont, unit prices (Dillman)	4426	1183		
Allan Wood Iron quotations 25% higher for iron than steel (Dillman).....	4806	1286		
At trench—detail of 5c per foot of riveted pipe (Dillman)	4429	1183		
Average, of all iron in riveted pipe in system (Hazen)			4313	1144
Borden Brook Dam, contract price of embankment (Hazen)			4946	1323
Brickwork earth dams—Herrmann's estimated prices independent of Hazen.....			4989	1340
Cement, at San Mateo (Hazen).....			5523	1498
Cement, higher at Riverside than at Los Angeles (Lippincott)			5521	1497
Cement, prices paid by Los Angeles in 1914 (Lippincott)			5518	1497
Cement, price 68 cents given by Dockweiler does not cover depreciation (Lippincott).....			5473	1482

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PRICES—Continued.				
Cement, Stockton St. Tunnel, San Francisco (Ellis)	5522	1497		
Cement used at Calaveras Dam 1914 (Lippincott)			5520	1497
Clearing—earth dams (Dillman)	5013	1347		
Clearing—contract price for Wild Horse Dam No. 2 (Vallejo, Cal.) (Noyes)	5269	1424		
Climate and location would increase price of work at Drum Forebay as compared with Pilarcitos (Herrmann)			5133	1382
Concrete—in earth dams (Dillman)	5025	1305		
	5028	1351		
Concrete—in puddle trench, Pilarcitos Dam (Dockweiler)	5057	1361		
Contract, average for Eeastern Dams (Hazen)			5430	1468
Crystal Springs Line—Crystal Springs Dam to Millbrae—unit prices (Dillman)	4422	1182		
Crystal Springs (Upper) Dam, Dillman used same unit prices as at San Andres (Dillman)	5027	1351		
Difference between, Hazen and Dillman on San Andres Pipe Line (Dillman)	4385	1170		
Difference in units between San Andres and Pilarcitos (Dillman)	5026	1351		
Dillman was told Allan Wood Iron could be delivered for 3½c per lb. in San Francisco	4720	1264		
Dull times makes a difference in prices of material (Hazen)			4815	1289
Earth dams—detail of estimates (Dillman)	5013	1347		
East Jersey Pipe Co. can sell pipe cheaper than other companies (Hazen)			4549	1217
Embankment—unit costs (Dillman)	5013	1347		
Estimated on riveted pipe line of Spring Valley method used (Hazen)			4377–4378	1168–1169
Excavation San Andres 44" line 51c a yd., backfill 20c a yd. (Dockweiler)	4436	1185		
Excavation, unit prices of Ellis compared to Hazen's	4998	1342		
From Lacy Bros. for riveted pipe (Dockweiler)	4615	1237		
Hartford, Conn., Dam, built for low price (Hazen)			5425	1466
Holyoke, Mass., Dam, price very low (Hazen)			5425	1466
If you pay a cheap price you get a poor pipe (Dorward)	4925	1318		
Inspection not mentioned when getting prices from Lacy Bros. (Dockweiler)	4615	1237		
Iron, charcoal for 54" Alameda Pipe Line 5½c per lb. (Hazen)			4354	1160
Iron, charcoal f.o.b. San Francisco (Hazen)			4326	1149

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PRICES—Continued.				
Iron, puddled, f.o.b. San Francisco (Hazen)			4327–4329	1149–1150
Iron, puddled, of extra quality for riveted pipe in Spring Valley system 4c per lb. (Hazen)			4353–4354	1160
Iron, puddled, ordinary for riveted pipe in Spring Valley system 3½c per lb. f.o.b. San Francisco (Hazen)			4354	1160
Labor—Ellis familiar with in San Francisco bay section	4886	1308		
Laying—Schaw-Batcher letter quoting prices (Dockweiler)	4653	1248		
Los Angeles Aqueduct—no contract price for pipe fabricated and delivered (Hazen)			4561	1220
Los Angeles contract for delivery of pipe at trench caulking and riveting (Hazen)			4338	1153
Lumber for flumes—obtained prices from Lawrence (Hazen)			5216	1406
Manufacture of Spring Valley pipe (Hazen)			4344	1156
1907 was a year of very high prices (Hazen)			4816	1289
On 54" pipe—$9.61 per foot dipped (Dockweiler)	4668	1251		
On lumber $11 per thousand including drayage for P. P. I. E. (Dillman)	4483	1198		
On steel for 1914 were lower than 1913 on the average (Dillman)	4723–4724	1265		
On steel obtained from "Iron Age" (Dillman)	4719	1264		
Ottawa, Can., contract on steel pipe 7½c per lb. f.o.b. (Hazen)			4338	1153
Ottawa, Can., job not closely comparable to San Francisco price (Hazen)			4495–4496	1202
Pipe contract in various cities (Hazen)			4337–4340	1153–1154
Pipe fabricated—Dillman's price for at trench, 5c per lb.	4325	1149		
Pipe made of thick plates, not applicable to pipe made of thin plates (Hazen)			4351	1159
Pipe riveted, basis of cost used by Hazen			4492	1201
Pipe riveted, comparison of unit prices of Hazen and Dockweiler (Hazen)			4490-4491	1200
Prices riveted, f.o.b. Ottawa, Can. (Hazen)			4495	1202
Price riveted, unit prices appear on Ex. 98 k and 98 i (Hazen)			4379	
Pipe, steel and wrought iron f.o.b. San Francisco compared (Hazen)			4802	1285
Pipe, steel in Spring Valley system 2¼c per lb. f.o.b. San Francisco (Hazen)			4354	1160
Pipe, steel, laid (Hazen)			4331–4332	1151
Pipe, steel, manufacturing of (Hazen)			4335–4336	1152–1153
Pipe, without accessories (Hazen)			4352	1159
Pipe, wrought iron, cost of manufacturing (Hazen)			4336	1153

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	Record	Abstract	Record	Abstract
PRICES—Continued.				
Pipe, wrought iron, 4c per lb. for metal agreed to by Dockweiler (Hazen)			4325	1149
Pipe, wrought iron, laid (Hazen)			4332–4333	1151
Plates, Dillman allows 1½c per lb. after arrival in San Francisco (Dillman)	4430	1183		
Pleasanton Line—applied Standard Spring Valley price to this job, which is too much (Dockweiler)	4605	1234		
Pleasanton Line, detail of estimated price (Dockweiler)	4604	1234		
Pleasanton Line, Dockweiler knew the contract price	4605	1234		
Portland, Ore., contract for delivery of pipe at trench caulking and riveting (Hazen)			4338	1153
Portland, Ore., contract for steel pipe 3.51c per lb. f.o.b. (Hazen)			4337	1153
Portland, Ore., from East Jersey Pipe Co. for riveted pipe (Hazen)			4494	1202
Puddling, contract for Modesto Irrigation District (Herrmann)			4984	1339
Puddling earth dams—unit cost of (Dockweiler)	5071	1365		
Puddling—unit cost of (Dillman)	5024	1350		
	5028	1351		
Puddling—unit prices for Pilarcitos Dam	5056	1361		
Quotations from Baker Iron Works' letter compared with Dockweiler's prices	4668	1251		
Quotations, some very low prices have been quoted for pipe made in California (Hazen)			4348	1157
Relaid Pilarcitos pipe worth as much as new pipe (Hazen)			4377	1168
Rip-rap—Baker Iron Works 24% higher than Lacy Bros. on that one weight of iron (Dockweiler)	4638	1243		
Rip-ráp—Dockweiler's unit prices for Pilarcitos Dam	5088	1361		
Rip-rap—Modesto Irrigation District (Herrmann)			5353	1442
Rip-rap—unit cost (Dillman)	5025	1350		
Riveted pipe—Baker Iron Works' letter, include dipping (Dockweiler)	4638	1243		
Riveted pipe—Dillman does not keep track of market	4688	1256		
San Andres Pipe Line—Hazen, Dockweiler, Dillman (Dillman)	4381	1169		
San Andres Pipe Line to Baden Trestle, detail (Dockweiler)	4437	1186		
San Andres Pipe Line—unit prices (Dillman)	4384	1169		
	4419	1181		

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	Record	Abstract	Record	Abstract
PRICES—Continued.				
Schaw-Batcher contract price on Park Line 87c per ft. (Hazen)			4536	1213
Seattle figures on riveted pipe not comparable to this case (Hazen)			4517	1208
Spring Valley paid a good price for pipe made by Risdon Iron Works (Dorward)	4925	1318		
Steel, actual price of plates for the year at Pittsburg 1.42c per lb. (Hazen)			4337	1153
Steel, average price in 1914 was below 1½c on tank plates (Metcalf)			4720	1264
Steel, average price, Metcalf table			4721–4722	1264–1265
Steel dropped because of Panama Canal opening (Dillman)	4676	1252		
Steel has been low since European war (Dockweiler)	4675	1252		
Steel higher today than in 1913 (Dillman)	4675	1252		
	4678	1252		
Steel pipe—Baker Iron Works quotes 3.7 cents per pound f.o.b. Los Angeles (Dockweiler)	4639	1243		
Submerged pipe, comparison of Hazen and Dockweiler prices			4774	1278
Submerged pipe, figures on, laid by Metcalf			4841	1296
Submerged pipe, pound price on Spring Valley based on quotations from Crane Co. (Dockweiler)	4773	1277		
Submerged pipe, there is a record of an old contract price on 16" submerged pipe (Hazen)			4771	1276
Tabeaud Dam—contract price of (Ellis)	5224	1409		
Trenching—earth dams—unit costs (Dillman)	5021	1349		
Trenching—riveted pipe—unit prices for in State Highway (Ellis)	4997	1342		
Western Pipe & Steel Co., Dockweiler did not submit specifications when asking for prices (Dockweiler)	4616	1237		
When asking Lacy Bros. for prices, Dockweiler told them he was making appraisal for S. F.	4613	1236		
Wild Horse Dam No. 2 (Vallejo, Cal.) contract price (Noyes)	5267	1423		
W. I. plates cost 70% more than steel f.o.b. S. F. (Hazen)			4802–4803	1285
PROFITS				
At present time on riv. pipe, 30 or 35%, ten or fifteen years ago profits were from 50 to 60% (Dorward)	4919	1319		
Contractors profit allowed on Pilarcitos Dam, by (Ellis)	5253	1419		
Contractors profit on Wild Horse Dam No. 2 (Vallejo, Cal.) (Noyes)	5267	1423		

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	Record	Abstract	Record	Abstract
PROFITS—Continued.				
Contractors profit would be about $6 per ft. more than would ordinarily be allowed (Dockweiler)	4788	1282		
Dorward costs on riv. pipe are without profit on the contract	4901	1311		
Dorward did not add any in his tables on Spring Valley riv. pipe	4919	1316		
In riveted pipe manufacture good up to 1910 (Dorward)	4921	1316		
In riveted pipe mfg. were reduced in 1910	4921	1316		
On riv. pipe would run from 15 to 25% between 1907 and 1912 (Moebus)	4934	1320		
Risdon Iron Works, adds a profit on riv. pipe over and above the 10 and 50% overhead (Dorward)	4902	1311		
Submerged pipe, contractors should expect more than 20% profit (Hazen)			4835	1294
Submerged pipe Dillman understood Risdon Iron Works made an enormous profit on Spring Valley job	4826	1291		
Was added to 10% overhead by Francis Smith Co. (Moebus)	4937	1321		
PUDDLE TRENCH				
Unit prices for concreting Pilarcitos Dam	5057	1361		
PUDDLING				
Central Reservoir-Oakland-description of puddle core and trench (Dockweiler)	5200	1402		
Central Reservoir-Oakland-there is a puddle core above the surface (Dockweiler)	5200	1402		
Central Reservoir-Oakland-was built without a puddle core above surface (Dockweiler)	5163	1392		
Contract price for, Modesto Irrigation Dist. (Herrmann)	4984	1339		
Core wall would settle with embankment (Dillman)	5177	1395		
Cost at Tabeaud Dam (Ellis)	5245	1416		
Cost of, Dry Canyon Dam-L. A. Aqueduct (Dockweiler)	5062	1362		
Cost of puddle fill Dry Canyon Dam L. A. Aqueduct (Dockweiler)	5199	1402		
Crystal Springs Dam—detail cost (Lippincott)			5486	1486
Description of various kinds of (Dillman)	5025	1350		
Difference in cost between Pilarcitos and San Andres Dams (Dockweiler)	5070	1364		
Distance of haul, Pilarcitos Dam (Dockweiler)	5056	1361		
Dockweiler has never seen a puddle core put in	5201	1402		
Dockweiler's proposed method of handling at San Andreas	5070	1364		
Drum Forebay embankment has no puddle core (Herrmann)			5136	1383
Earth Dams, general remarks (Hazen)			4953	1326

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	Record	Abstract	Record	Abstract
PUDDLING—Continued.				
Earth Dams, unit costs (Hazen)			4953	1326
Excavation cost South Haiwee, L. A. (Herrmann)			5116	1377
Is not always necessary in dams (Dillman)	5026	1351		
Location of borrow-pits Pilarcitos Dam (Dockweiler)	5054	1360		
Method of, Modesto Irrigation District (Herrmann)	4984	1339		
Method of, Pilarcitos (Dillman)	5159	1390		
Modesto Irrigation District, detail of estimate (Herrmann)	4984	1339		
Not necessary if general material of dam is compacted (Dillman)	5162	1391		
Percentage of settlement in puddle core and embankment (Dillman)	5164	1392		
Pilarcitos Dam (Herrmann)			4983–4984	1338–1339
Pilarcitos Dam, unit cost of (Hazen)			4956	1328
San Andreas Dam			4983–4984	1338–1339
San Andreas Dam, unit costs (Hazen)			4953	1326
Supporting data on, from L. A. Aqueduct (Dockweiler)	5062	1362		
Tabeaud Dam was built without puddle (Dillman)	5181	1396		
Trench and concrete—unit cost (Herrmann)			4986	1340
Unit cost of (Dillman)	5024–5028	1350–1351		
Unit cost of, on earth dams (Dockweiler)	5071	1365		
Unit prices for Pilarcitos Dam (Dockweiler)	5056	1361		
Vallejo Dam was built without puddle (Dillman)	5181	1396		
Weight per cu. yd. of puddle core at Pilarcitos (Dillman)	5160	1391		
Wrought iron is worked easier than steel in punching and caulking (Dillman)	4413	1179		
QUALIFICATIONS				
Dillman, Geo. D.	4255–4274	1127–1132		
Dockweiler, J. H.	4193	1110		
	4253	1126		
Dorward, David	4889	1309		
Elliott, Geo. A.			5382	1452
Ellis, N. Randall	4882	1308		
Hazen, Allen			4163–4179	1099–1105
Herrmann, F. C.			4958–4961	1329–1330
Lawrence, W. B.			4275	1132
Lippincott, J. B.			5461–5462	1478
Metcalf, Leonard			4180–4191	1105–1110
Moebus, F. W. G.	4929	1319		
Noyes, A. P.	5260	1421		
Rhodes, C. I.	4737	1267		
QUANTITIES				
See structure or material in question				

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	Record	Abstract	Record	Abstract
QUARRIES				
Crystal Sprigns Dam, information on, obtained from Mr. Schussler and Mr. Lawrence (Hazen)			5416	1462
Crystal Springs Dam location of (Lippincott)...			5477	1483
Rip-rap, location of, Pilarcitos Dam.....	5058	1361		
Rip-rap Pilarcitos Dam, Dockweiler's cost of...	5058	1361		
QUARRYING				
Rip-rap on Wild Horse Dam did not include quarrying (Herrmann)			5356	1444
QUOTATIONS				
Alameda Pipe Line—excavation quotation from Minute Book "D" (Lawrence).....			5333	1438
Allan Wood 25% higher for iron than steel manufactured (Dillman)	4806	1286		
Are invariably cut in the bids (Dillman).....	4482	1198		
Carey's testimony in 1904 case in re—dipping riveted pipe (Lawrence).....			5323	1436
Dillman did not get any, on riveted pipe (Dillman)	4688	1256		
Dockweiler did not get any, from Eastern pipe houses	4622	1239		
Dockweiler got quotations from Healy & Tibbitts on barge and tugboat service for laying submarine pipe	4782	1279		
From "Iron Age" were on steel plates less than ¼" (Dillman)	4721	1264		
From letter of Baker Iron Works to Dockweiler	4638	1243		
	4667	1250		
From manufacturers not to be depended on (Hazen)			4519	1209
.....			4569	1224
From Minute Book "F" on pipe.....	4470	1195		
From Schussler report in re settling of Pilarcitos Dam	5178	1396		
From Western Pipe & Steel Co. in re fabrication of riveted pipe (Dockweiler).....	4449	1190		
Healy & Tibbitts' table showing detailed cost of laying submerged pipe (Dockweiler).....	4782–4783	1279–1280		
On riveted pipe from Western Pipe & Steel Co. (Dockweiler)	4469	1195		
On Spring Valley submerged pipe furnished by Crane & Co. (Dockweiler).....	4773	1277		
On steel for 1913-14-15 (Dillman).....	4719	1264		
On submerged pipe from New Jersey Tube Co. (Hazen)			4773	1277
Risdon Iron & Locomotive Works bid on 44" riveted pipe $3.425 per ft. or .0283 per lb. (Dockweiler)	4471	1195		

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	Record	Abstract	Record	Abstract
QUOTATIONS—Continued.				
Riveted pipe—Dillman does not keep track of market	4688	1256		
Riveted pipe generally, by lineal ft. (Dillman)	4689	1256		
Schaw-Ingraham-Batcher Co. bid on 44" riveted pipe $1.65 per ft. or .0136 per lb. (Dockweiler)	4471	1195		
There is a variation in quotations on good and poor pipe (Dorward)	4927	1319		
Union Iron Wks. bid on 44" riv. pipe $4.35 per ft. or .036 per lb. (Dockweiler)	4471	1195		
Usually higher than bids (Dockweiler)	4478	1197		
W. I. from Allan Wood added 25% to cost of steel (Dillman)	4695	1258		
RAILROADS				
Settling—percentage of—in railroad embankments (Dillman)	5165	1392		
RAVENSWOOD PIPE LINE				
Basis of Dillman's estimate on cost of (Dillman)	4850	1299		
Dillman's estimate of cost (Dillman)	4849–4850	1299		
Dillman inspected	4825	1291		
Dredging cost of—less than at Portland (Dillman)	5000	1343		
Examination of (Dillman)	4853	1300		
Submerged pipe seemed to be in good condition (Dillman)	4854	1300		
Tidal currents were very strong at Ravenswood (Hazen)			4834	1294
REAL ESTAE SALES				
Husing to Bourn—Pen. land			4283	1136
O'Rourke Est. allowed in evidence—ruling in favor of City			4159	
RECORDS				
Bids submitted to San Diego (Dockweiler)	4671	1251		
Cost—Los Angeles, by J. G. White Co. (Dockweiler)	4585	1229		
Data on steam shovel work Central Reservoir—Oakland—obtained by Dockweiler from Peoples Water Co.	5039	1355		
Description of Spring Valley records at Millbrae (Lawrence)			5325	1436
Dockweiler's estimate—timbering earth dams based on Spring Valley records	5051	1359		
Dockweiler's estimate trenching earth dams based on Spring Valley records	5051	1359		
Dockweiler has had access to the cost records of the Spring Valley Water Co.	4432	1184		
Dockweiler has records of steam shovel work on Franklin Canyon Dam, Los Angeles	5033	1353		

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RECORDS—Continued.				
Excavation—cost records of, Seattle, Portland and Victoria used (Hazen)			4564	1222
Los Angeles—Dockweiler obtained from Mr. Mulholland, records of riveted steel pipe (Dockweiler)	4671	1251		
Mill, shows weight of submerged pipe (Hazen)			4865	1302
Of Spring Valley basis of values submerged pipe (Dockweiler)	4860	1301		
	4876	1305		
Riveted pipe—original cost could be worked up from Spring Valley records (Lawrence)			5326	1436
Riveted pipe—show partial cost only (Lawrence)			5327	1436
Steam shovel work Central Reservoir—Oakland (Dockweiler)	5201	1402		
Steam shovel work on Franklin Canyon Dam L. A. (Dockweiler)	5037	1354		
System used in keeping Spring Valley records of riveted pipe, labor and material (Lawrence)			4410	1178
REITTER CONNOLLY MFG. CO.				
Bid on San Diego riveted pipe (Dockweiler)	4798	1284		
REPORTS				
Dillman made a report on La Mesa Dam to New England Trust Co.	5012	1347		
Dockweiler termed settling described in Schussler report as a "Slip"	5179	1396		
Quotations from Schussler report in re—settling of Pilarcitos Dam	5178	1396		
REPRODUCTION COST				
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RHODES, C. I.				
Direct examination (riveted pipe)	4737–4752	1267–1271		
Re-direct (riveted pipe)	4752	1271		
Re-cross (riveted pipe)	4752–4759	1271		
Caulking steel pipe, method used by Monterey Water Co.	4751	1270		
Fabrication, methods have improved	4754–4755	1271		
Labor cost on steel pipe for Monterey Water Co.	4750	1270		
Pipe for P. P. I. E. made by Schaw-Batcher was weighed after dipping	4756	1272		
Pipe riveted, kept analysis of cost	4739	1267		
Power consumption, Monterey Water Co. method of determining average	4741	1268		
Power cost per month for Monterey Water Co.'s steel pipe	4742	1268		
Qualifications	4737	1267		
Specifications for Monterey Water Co. steel pipe very rigid	4738	1267		

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RHODES, C. I.—Continued.	Record	Abstract	Record	Abstract
Specifications, summarization of, for steel pipe, Monterey Water Co.	4739	1267		
Steel pipe, difficult to get tight	4750	1270		
Steel pipe, general remarks on manufacture of, for Monterey Water Co.	4744–4749	1268–1270		
Steel pipe, maximum pressure of Monterey Water Co.	4738	1267		
Steel pipe, Monterey Water Co. inspected by	4737	1267		
Steel pipe, Monterey Water Co. machinery used in manufacture	4742–4743	1268		
Steel pipe, Monterey Water Co. made by W. W. Montague & Co.	4737	1267		
Steel pipe, Monterey Water Co. required hydraulic pressure of 175 lbs. per sq. ft. before dipping	4739	1267		
RIFFLE, MR.				
Obtained information from, in re labor (Dockweiler)	4632	1242		
RIP-RAP				
Earth dams, unit cost (Herrmann)			4987	1340
Examination of, Pilarcitos Dam (Hazen)			4952	1326
Hauling and placing Pilarcitos Dam, cost of (Dockweiler)	5058	1361		
Loose, unit cost (Herrmann)			4987	1340
Modesto Irrigation District, bids for (Herrmann)			5356	1443
Modesto Irrigation District, contract prices on (Herrmann)			5353	1442
Modesto Irrigation District not comparable to Howard cut (Herrmann)			5355	1443
Pilarcitos Dam, average thickness of (Hazen)			5455	1476
Pilarcitos Dam, general remarks (Noyes)	5272	1426		
Pilarcitos Dam, location of quarries (Dockweiler)	5058	1361		
Quarrying Pilarcitos Dam, cost of (Dockweiler)	5058	1361		
San Andres better than at Pilarcitos (Herrmann)			4987	1340
Specifications on Modesto Irrigation District work (Herrmann)			5359	1444
Suitable material more available on Modesto works than at Pilarcitos and San Andres			5359	1444
Tabeaud Dam, not hand laid (Ellis)	5226	1410		
Unit costs (Dillman)	5025	1350		
Unit prices for Pilarcitos Dam (Dockweiler)	5058	1361		
Wild Horse Dam No. 2 (Vallejo, Cal.) did not include quarrying (Herrmann)			5356	1444
Wild Horse Dam No. 2 (Vallejo, Cal.) character of (Noyes)	5268	1424		
Wild Horse Dam No. 2 (Vallejo, Cal.) cost of (Noyes)	5273	1425		
Wild Horse Dam No. 2 (Vallejo, Cal.) laid in gravel (Noyes)	5271	1425		

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RISDON IRON AND LOCOMOTIVE WORKS				
Bid on 44" riveted pipe $3.425 per ft. or .0283 per lb. (Dockweiler)	4471	1195		
Caulking, Dockweiler observed costs	4640	1244		
Cleaning, cost of, observed by Dockweiler	4640	1244		
Contra Costa Water Co., pipe line built by Dillman, was fabricated by Risdon	4686	1255		
Dorward never had any actual costs from books	4892 4897	1310 1311		
Dorward says pipe was made to comply with Spring Valley specifications	4896	1310		
Fabricating riveted pipe, methods used (Dorward)	4907	1313		
Labor, visited by Dockweiler to get costs of	4636	1243		
Manufacture of pipe for Spring Valley, method used (Dorward)	4923–4925	1317–1318		
No better pipe could be made than pipe made for Spring Valley (Dorward)	4922	1317		
One day at plant only information Dockweiler had as to cost	4640	1244		
Overhead 50% on riveted pipe does not include shop profit (Dorward)	4902	1311		
Riveted pipe adds 10% for handling and 50% for labor (Dorward)	4901	1311		
Riveted pipe made by, very good (Hazen)			4525	1210
Shop labor, etc., on Spring Valley riveted pipe (Dorward)	4914–4915	1315		
Shop work on riveted pipe, detail of (Dorward)	4907–4909	1313–1314		
Submerged pipe, Dillman understood Risdon Iron Works made an enormous profit on Spring Valley job	4826	1291		
Table by Dorward showing cost of fabricating and laying original Spring Valley pipes	4891–4899	1309–1311		
Weights of Spring Valley riveted pipe, method of obtaining (Dorward)	4908	1313		
RIVERSIDE				
Prices for cement higher than at Los Angeles (Lippincott)			5521	1497
RIVETING				
Akron, Ohio, contract price for delivery of pipe at trench, including caulking (Hazen)			4338	1153
Big houses would do same kind, with or without specifications	4592			
Cost, if properly done, is quite an item in cost (Hazen)			4803	1285
Cost of (Hazen)			4803	1285
Cost of, Dillman does not care to go into detail	4431	1184		
Dillman did not figure on Spring Valley riveting	4698	1259		
Dillman did not use boilermakers' standard	4697	1258		

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RIVETING—Continued.				
Dillman does not know if Oakdale Irrigation District line is riveted like Pleasanton line of Spring Valley	4732	1266		
Dockweiler never figured riveting strength as compared to strength of plate	4607	1235		
Los Angeles, contract price includes delivery at trench and caulking (Hazen)			4338	1153
Methods adopted by Dockweiler	4591	1229		
Method employed by Spring Valley (Hazen)			4311–4312	1143–1144
Most Spring Valley pipe made as well as any Dillman knows of	4713	1263		
Necessary to develop full strength of pipe (Hazen)			4349	1157
Oakdale Irrigation District under-riveted for high pressure (Dillman)	4731	1266		
Pacific Coast, methods can not be taken as standard of cost without proper inspection (Hazen)			4350	1158
Park line under Spring Valley standard (Metcalf)			4524	1210
Pipe made by best factories not always as well riveted as Spring Valley pipes (Dillman)	4713	1263		
Pipe made in California inferior to Spring Valley pipe (Hazen)			4348	1157
Pleasanton line, under-riveted, Dockweiler never examined	4601	1233		
Portland, Ore., contract price includes caulking and delivery at trench (Hazen)			4338	1153
Portland, Ore., cost of includes caulking ¼" plate in trench (Hazen)			4495	1202
Samples of Spring Valley riveted pipe explained by Hazen			4358–4361	1162–1163
Shop cost, detail of (Dockweiler)	4627	1240		
Under-riveting, meaning of (Dockweiler)	4601	1233		
RIVETS				
Average cost .0688c (Lawrence)			4397	1174
Weight in pipes amount to 4% of weight (Hazen)			4330	1150
ROADS				
Clearing cost, Calaveras-Sunol Road (Herrmann)			4964	1331
Clearing Pilarcitos Reservoir cost 15% more than Calaveras-Sunol Road (Herrmann)			4964	1331
Included in Spring Valley estimate at syphon on Pilarcitos work (Hazen)			4560	1220
Steam shovel could be taken into Pilarcitos over existing roads (Dockweiler)			5047	1357
Steam shovel could not be taken into Pilarcitos over existing roads (Herrmann)			5046	1357
Tabeaud Dam, general remarks (Ellis)			5250	1418

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ROADS AND TRAILS				
Calaveras, cost more than is shown by Los Angeles schedule (Herrmann)			5117	
Cost of clearing at Calaveras Dam (Herrmann)			5118	1378
Los Angeles Aqueduct, items (Lippincott)			5489	1488
Pilarcitos Dam (Herrmann)			5117	1378
ROAD WORK				
Riveted pipe, items charged for (Lawrence)			5331	1437
ROCHESTER, N. Y.				
Laying, coating and condition of wrought iron and steel pipe lines (Hazen)			4545	1215
ROCK				
Crystal Springs Dam (Lippincott)			5477	1483
Crystal Springs Dam, assumed it would be quarried at dam (Lippincott)			5527	1498
Crystal Springs Dam, cost of (Hazen)			5417	1462
(Lippincott)			5477	1484
Crystal Springs Dam, estimated cost at dam (Lippincott)			5527	1498
Crystal Springs Dam, location of quarry (Lippincott)			5477	1483
Crystal Springs Dam, not very good quality (Hazen)			5416	1462
Crystal Springs Dam, some would be rejected in quarrying (Hazen)			5439	1471
Quarries, Crystal Springs Dam, information obtained from Mr. Schussler and Mr. Lawrence			5416	1462
ROLLING				
Material in dams rolled in 12" layers (Ellis)	5239	1415		
One cent allowed in Ellis' estimate for	5257	1420		
Tabeaud Dam, method used (Ellis)	5257	1420		
ROOSEVELT DAM				
Stripping, bids for (Lippincott)			5533	1500
Stripping, cost of (Lippincott)			5484	1485
SACRAMENTO, CAL.				
Bids received for riveted steel and cast iron pipe, etc. (Dockweiler)	4473–4475	1196–1197		
Coating of Spring Valley better than Sacramento job (Ellis)	4812	1288		
Estimates made on Sacramento Water Supply project for San Francisco by Hazen			4489	1200
Excavation is easier than in and around San Francisco (Hazen)			4574	1225
Pipe, cost of different sizes (Dockweiler)	4814	1288		
Riveted pipe, Sacramento job (Dockweiler)	4810			
Riveted pipe specifications (Dockweiler)	4510–4814			
Specifications quoted by Dockweiler on this job not unusual	4813	1288		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
SAMPLES, RIVETED PIPE				
Riveting and caulking explained (Hazen)			4358–4361	1162–1163
SAN ANDRES DAM				
Clearing, cost of (Hazen)			4953	1326
Compared to Lake Arthur Dam (Herrmann)			5139	1384
Construction, as fine as any in the country (Herrmann)			4990	1341
Construction, general remarks (Hazen)			4945	1322
Construction of, compared to Borden Brook Dam (Springfield, Mass.) (Hazen)			5083	1367
Cost, estimated unit (Hazen)			4950	1325
Cost, no attention paid to original cost in 1913 estimate (Hazen)			5111	1375
Cost of, estimated (Herrmann)			4973	1334
Cost of total estimate (Hazen)			4950	1325
Costs on various methods of work (Herrmann)			4976–4977	1335–1337
Cost units same as Pilarcitos Dam (Herrmann)			4963	1330
Difference between Dockweiler's and Hazen's unit cost as applied Pilarcitos Dam	5066–5068	1363		
Difference in units between San Andres and Pilarcitos (Dillman)	5026	1351		
Dockweiler's units compared with Hazen's and Herrmann's	5072	1365		
Embankment estimated cost per cu. yd. (Hazen)			4948	1324
Embankments, estimated cots of (Ellis)	5231	1412		
Estimate based on experience (Hazen)			4945	1322
Examination of (Ellis)	5230	1411		
Formation not studied (Elliott)			5407	1458
Lagging, cost of	5156	1389		
Material, cost of placing less with steam shovel than with scrapers (Ellis)	5235	1413		
New Era Graders could be used in borrow-pits below dam (Dillman)	5281	1427		
New Era Graders could not be used on (Dillman)	5280			
Powder, not much used (Herrmann)			5154	1389
Puddle, proposed method of handling (Dockweiler)	5070	1364		
Puddling (Herrmann)			4983–4984	1338–1339
Puddling, difference in cost of between Pilarcitos Dam and (Dockweiler)	5070	1364		
Puddling, unit cost (Hazen)			4953	1326
Quantities (Hazen)			4950	1325
Quantities stripping, embankment (Herrmann)			4975	1335
Reproduction, estimates two years to reproduce by his methods (Hazen)			5083	1367
Reproduction, proposed method of (Ellis)	5232	1412		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
SAN ANDRES DAM—Continued.				
Rip-rap better than at Pilarcitos (Herrmann)..			4987	1340
Rip-rap, Herrmann does not know where it was obtained (Herrmann)			5359	1445
Rip-rap, suitable material more available at Modesto works than at Pilarcitos and San Andres (Herrmann)			5359	1445
San Mateo Creek Dams, same unit cost used (Hazen)			4956	1328
Steam shovel work, conditions not comparable to San Fernando and Franklin Dams (Elliott)..			5389–5390	1454
Stripping, estimated cost of (Ellis).....	5232	1412		
Timbering, cost of (Dillman)	5156	1389		
Transporting, detail of (Dockweiler).....	5047	1357		
Trenching, difference in cost, etc., between Pilarcitos Dam (Hazen)			5068–5069	1363–1364
Trenching, unit costs (Dillman)	5027	1351		
Unit costs, compared to Pilarcitos (Dockweiler)	5066	1363		
Unit costs detailed (Ellis)	5232	1412		
SAN ANDREAS FLUME				
Hauling, estimated cost (Herrmann)			5369	1448
SAN ANDREAS PIPE LINE				
Amount of riveted iron pipe and date laid (Hazen)			4305	1141
Analysis shows iron furnished for (Lawrence)..			4396	1174
Analysis showing accessories 1897-1898 (Lawrence)			4403	1176
Bends and manholes, cost of (Hazen)			4341	1155
Carpenter work on, explained (Lawrence).....			5303	1432
Cost compared with Dockweiler and Dillman's estimates (Hazen)			4380	1169
Cost per foot (Hazen)			4378	1169
Difference in cost between Hazen and Dillman (Dillman)	4385	1170		
Dillman has not figured total weight of line....	4422	1182		
Dillman's unit prices on Item 11.....	4384	1169		
Excavation on 44", 51c a yard, backfill 20c a yard (Dockweiler)	4436	1185		
Excavation on 44", total cost of, $28,313.38 (Dockweiler)	4437	1186		
Extras amount to $2,795 (Dillman).....	4420	1182		
44", description of work (Lawrence)			5334	1438
44" riveted wrought iron pipe bought by gauge (Hazen)			4308	1142
44" x ¼" cheapest work Spring Valley ever did (Hazen)			4567	1223
44" x ¼" cost and estimate (Hazen)			4567	1223

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
SAN ANDREAS PIPE LINE—Continued.				
Merced Branch, analysis shows iron furnished for (Lawrence)			4396	1174
Merced Branch, analysis showing actual time and cost (Lawrence)			4406	1177
Metal, cost of (Hazen)			4341	1155
Overhead, Dillman's total cost	4380	1169		
Overhead, on Structure 11, page 21, Hazen 28.8% Dillman 15½% (Dillman)	4381	1169		
Overhead, total cost does not include Structure 11, page 21 (Dockweiler)	4380	1169		
Screen tank to Baden, analysis showing actual time and cost			4400	1175
Total $278,653 or $9.20 per ft. (Dillman)	4420	1182		
Transportation cost of pipe from shop to ditch (Hazen)			4343	1155
Unit prices (Dillman)	4419	1181		
Unit prices on Structure 11, page 21, Hazen, Dockweiler, Dillman (Dillman)	4381	1169		
Watchman's time explained (Lawrence)			5305	1432
Weight of different sizes of pipe on (Dockweiler)	4437	1186		
SAN BRUNO				
Dillman examined pipes taken up at (Dillman)	4695	1258		
SAND				
Crystal Springs Dam, amount required (Hazen)			5420	1464
Crystal Springs Dam, cost as per letter Spring Valley purchasing agent (Lippincott)			5475	1483
Crystal Springs Dam, cost of (Hazen)			5415	1462
			5420	1464
Crystal Springs Dam could be obtained from Niles Cone (Lippincott)			5475	1483
Crystal Springs Dam, difficulty of obtainng (Hazen)			5420	1464
Crystal Springs Dam, estimated cost at Niles (Lippincott)			5526	1498
Crystal Springs Dam, estimated cost of at San Mateo (Lippincott)			5525	1498
Crystal Springs Dam, points from which it could be obtained (Hazen)			5411	1460
Crystal Springs Dam, sand obtained from North Beach, San Francisco (Dockweiler)			5474	1482
Crystal Springs Dam, sufficient quantities not to be had near by (Lippincott)			5474	1485
Crystal Springs Dam, total cost of per cu. yd. on job (Hazen)			5416	1462
Crystal Springs Dam, weight of (Lippincott)			5476	1483
Equipment for handling at Crystal Springs Dam, cost of (Hazen)			5415	1462
Hauling, cost of, Crystal Springs Dam (Hazen)			5416	1462

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
SAN DIEGO				
Lacy Mfg. Co.'s bid on riveted pipe (Dockweiler)	4798	1284		
Llewelln Iron Works' bid on riveted pipe (Dockweiler)	4798	1284		
Pressure tests on San Diego riveted pipe (Dockweiler)	4795	1283		
Records of bids submitted to city (Dockweiler)	4671	1251		
Reitter Connolly Mfg. Co. bid on riveted pipe (Dockweiler)	4798	1284		
Specifications for riveted pipe not particularly onerous (Dockweiler)	4795	1283		
Specifications on which bids were based (Dockweiler)	4672	1252		
Specifications, summarization of, on riveted pipe (Dockweiler)	4794	1283		
Western Pipe & Steel Co.'s bid on San Diego riveted pipe (Dockweiler)	4797	1284		
SAN FERNANDO DAM, LOS ANGELES AQUEDUCT				
Method of blasting, in steam shovel pit (Dockweiler)	5198	1401		
Steam shovel capacity (Elliott)			5384	1453
Steam shovel conditions better than at Calaveras (Elliott)			5386	1453
Steam shovel delivery (Elliott)			5383	1452
Steam shovel work, conditions not comparable to Pilarcitos and San Andreas Dams (Elliott)			5389–5390	1454
Visits to (Elliott)			5404	1458
Voids in material handled by steam shovel (Elliott)			5391	1455
SAN FRANCISCO				
Labor conditions at (Hazen)			4840	1296
Labor conditions, made inquiries concerning (Hazen)			4568	1223
			4574	1225
There is not much difference in the wage schedule between Los Angeles and (Dockweiler)	4455	1192		
SAN LEANDRO DAM				
Dillman saw construction of last portion of San Leandro Dam	5011	1347		
Dockweiler familiar with	5029	1352		
Vallejo Dam is just as good as (Dillman)	5181	1396		
Work was very expensive (Dillman)	5011	1347		
SAN MATEO				
Cement, estimated cost at (Lippincott)			5471	1481
			5474	1482
Cement, price of (Hazen)			5523	1498
Labor, 8-hour day is observed in San Mateo Co. (Herrmann)			4409	1178
(Lawrence)			4964	1331

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
SAN MATEO—Continued.				
Labor would organize in San Mateo on a large job (Lawrence)			5322	1435
Lumber, cost of (Lippincott)			5478	1484
Sand, estimated cost of at San Mateo (Lippincott)			5525	1498
SAN MATEO CREEK DAMS				
Dillman's detailed estimate cost	5028	1351		
Discussion of			5079–5081	1366–1367
Not as costly as Colma Dam (Hazen)			4956	1328
Not of any special value to the works (Dillman)	5028	1315		
Purpose of (Dockweiler)	5079	1366		
Same unit cost as Pilarcitos and San Andreas Dams (Hazen)			4956	1328
Unit costs, Dockweiler's explanation of	5078	1366		
SANTA BARBARA				
Cement, cost of at (Lippincott)			5470	1481
SCHAW-BATCHER CO.				
Bid from, for pipe explained by Hazen (Hazen)			4471–4472	1195–1196
Bid on 44" riveted pipe, $1.65 per ft. or .0136 per lb. (Dockweiler)	4471	1195		
Contract price on Park Pipe Line 87c per ft.			4536	1213
Laying, comparison of Dockweiler's costs and costs in Schaw-Batcher letter for 44" (Dockweiler)	4663	1249		
Laying riveted pipe, letter from, quoting prices (Dockweiler)	4653	1248		
Letter from to Dockweiler re cost of riveted pipe (Dockweiler)	4470	1195		
Letter from to Spring Valley Co. (Dockweiler)	4653	1248		
Pipe made by, for P. P. I. E. was weighed after dipping and paid for by weight (Rhodes)	4756	1272		
Rhodes does not know anything of Schaw-Batcher's shop cost on P. P. I. E. pipe	4755	1271		
Rhodes inspected pipe for P. P. I. E. in Schaw-Batcher Works	4755	1271		
Work 8-hour day, Western Steel & Pipe Co. 9-hour, pay same ratio (Dockweiler)	4625	1240		
SCHEDULES				
Submerged pipe, difference between Hazen and Dockweiler as to number of lengths of pipe			4819	1290
SCHUSSLER, HERMAN				
Coating, cost of dipping pipe with, has been one cent times diameter in inches per lineal foot of pipe exclusive of Overhead and Interest			4399	1175
Dillman could obtain no information in re earth dams from	5167	1393		

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
SCHUSSLER, HERMAN—Continued.				
Dillman never read his specifications for wrought iron plates	4691	1257		
Dockweiler familiar with Schussler's testimony	5029	1352		
Dockweiler termed settling that was described in Schussler report as a "slip"	5179	1396		
Quotations from Schussler report in re settling of Pilarcitos Dam	5178	1396		
Ranks highest in United States on riveted pipe (Hazen)			4375	1168
Specifications for riveted pipe were good			4572	1225
Specifications of Oliver Steel Co. (Hazen)			4806	1286
SCHUYLER, JAMES D.				
Report on Tabeaud Dam (Ellis)	5228	1411		
SCRAPERS, FRESNO				
Cost of, with drivers, Alamo Dam, Imperial Valley (Herrmann)			5140	1384
Dillman had experience with	5012	1347		
SEATTLE				
Figures on riveted pipe not comparable to this case (Hazen)			4517	1208
SERVICE.—CITY DISTRIBUTION				
Lake Honda, largest and most important (Hazen)			4278	1134
La Honda, University Mound, College Hill, three larger (Hazen)			4278	1134
Not adequate at present time (Hazen)			4279	1134
SETTLEMENT				
More at Pilarcitos Dam than at Tabeaud Dam (Ellis)	5241	1415		
Wild Horse Dam No. 2 (Vallejo, Cal.) (Noyes)	5265	1423		
SETTLING				
A good dam would not settle (Hazen)			5177	1395
Dockweiler termed settling that was described in Schussler report, as a "slip"	5179	1396		
Earth-dams-core wall would settle with embankment (Dillman)	5177	1395		
Earth-dams, Hazen says it is possible to build dams that will not settle			5185	1398
Earth-dams, percentage of, in puddle core and embankment (Dillman)	5164	1392		
Earth-dams, well built dam would not settle appreciably (Hazen)			5184	1397
Percentage of, in railroad embankments (Dillman)	5165	1392		
Quotations from Schussler report in re settling of Pilarcitos Dam	5178	1396		
SHAFTS				
Elizabeth Tunnel, cost of excavating (Lippincott)			5534	1500

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
SHARON, J. J.				
Information given by, to Bailhache in re lumber			5330	1437
Re Pleasanton Buildings			4822	
Re wrought iron pipe fabricating costs			4535	
SHEARING				
Specifications, Dockweiler would require bevelling and shearing on riveted pipe	4610	1235		
SHEETING				
Sunol Filter Galleries, description of (Hazen)			5455–5456	1476
SHOPS				
Riveted pipe, too many in California (Hazen)			4815	
SHRINKAGE				
Of material in embankment (Dillman)	5160	1391		
	5238	1414		
SIERRA—FLUMES				
Flumes not comparable to Spring Valley flumes (Herrmann)			5372	1449
Flumes not ordinarily caulked (Herrmann)			5372	1449
SLIPS				
Dockweiler termed settling, described in Schussler report as a "slip"	5179	1396		
SMITH & CO., FRANCIS				
Chenery St., riveted pipe Mr. Moebus referred to might have been laid by (Metcalf)			5019	1349
SOUTHERN PACIFIC				
Labor payrolls of Southern Pacific in neighborhood of San Francisco used by (Hazen)			5097	1371
			5089	1369
SOUTH SAN JOAQUIN IRRIGATION DISTRICT				
Flumes, cost of (Herrmann)			5363	1446
SPAULDING DAM				
Cement, cost of (Hazen)			5432	1468
(Lippincott)			5433	1469
			5520	1497
Comparable in general way to Crystal Springs Dam (Hazen)			5432	1468
Gravel, for, was brought in by rail about 30 miles (Hazen)			5432	1469
Hazen made inquiries regarding			5432	1468
Plums used, percentage of (Lippincott)			5528	1499
SPECIFICATIONS				
And plans prepared for pipe work in Los Angeles (Dockweiler)	4590	1229		
Bids sometimes run above preliminary estimates when based on specifications			4567	1223
Buying riveted pipe, Dockweiler would specify gauge	4609	1235		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
SPECIFICATIONS—Continued.				
Dillman has assumed that requirements of, will not be more expensive than necessity requires (Dillman)	4412	1178		
Dorward did not pay attention to specifications in making up cost	4895	1310		
Fabrication of riveted pipe for largest line used by Spring Valley	4591	1229		
For Monterey Water Co., steel pipe required, hydraulic pressure of 175 lbs. per sq. in. before dipping (Rhodes)	4739	1267		
For Monterey Water Co.'s steel pipe summarization of (Rhodes)	4739	1267		
For Monterey Water Co., steel pipe very rigid (Rhodes)	4738	1267		
For Park line for field test of 200 lb. per sq. in. (Dockweiler)	4525	1210		
For San Diego riveted pipe not particularly onerous (Dockweiler)	4796	1284		
Inspection, Dockweiler would require	4598	1232		
Los Angeles, pipe in schedule furnished by Mulholland, fabricated under specifications (Dockweiler)	4685	1254		
Lumber, for flumes (Lawrence)			5374	1449
None furnished by Spring Valley for Merced and Pleasanton lines (Hazen)			4522	1209
Of Schussler-Oliver Steel Co. (Hazen)			4806	1286
On which San Diego bids were based (Dockweiler)	4672	1252		
On Winnipeg job, were special (Hazen)			4498	1203
Pilarcitos Dam, show 12" layers used (Searls)	5244	1416		
Pipe was made to comply with Spring Valley specifications by Risdon Iron Works (Dorward)	4896	1310		
Plates, Dillman has not read Spring Valley specifications	4485	1199		
Quoted by Dockweiler on Sacramento job not unusual	4813	1288		
Received by City of Sacramento for riveted steel and cast iron pipe, etc. (Dockweiler)	4473–4475	1196–1197		
Rip-rap work, Modesto Irrigation District (Herrmann)			5359	1445
Riveting, big house would no same kind with or specifications (Dockweiler)	4592	1230		
Riveted pipe, Dockweiler would require bevelling and shearing	4610	1235		
Riveted pipe, Schussler's were good (Hazen)			4572	1225
Riveted pipe should require proper inspection (Dockweiler)	4596	1232		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
SPECIFICATIONS—Continued.				
Riveted pipe, Spring Valley's were very rigid (Hazen)			4571	1224
Riveted pipe, what they contain (Dockweiler)	4590	1229		
Riveted pipe, would get better pipe by specifying what you wanted (Dockweiler)	4611	1236		
San Diego riveted pipe, summarization of (Dockweiler)	4794	1283		
Schussler's for wrought iron plates, Dillman never read	4691	1257		
Spring Valley for fabricating and laying, Dorward familiar with	4895	1310		
Submerged pipe, tightness of Spring Valley pipe had to be demonstrated (Hazen)			4837	1295
Tabeaud Dam, contractor compelled to live up to (Ellis)	5250	1418		
Tabeaud Dam, extracts from (Ellis)	5225–5228	1409–1411		
268, Los Angeles were drawn on a weight basis (Dockweiler)	4610	1235		
What they should contain (Hazen)			4571	1224
Wild Horse Dam No. 2 (Vallejo, Cal.) extracts from (Noyes)	5263–5270	1422–1425		
With Dillman's prices, he would not consider it a good contract, if it had to be done with antagonistic supervision (Dillman)	4412	1178		
SPRINGFIELD, MASS.				
Character and cost of work on dams built by Hazen			5095	1371
Contract price of embankment for Borden Brook Earth Dam (Hazen)			4946	1323
Cost of laying 30″ submerged pipe (Hazen)			4768	1275
Cost of 32″ riveted pipe line built by supporting 10% addition to excavation for accessories			4362	1163
Description of Dam (Hazen)			5424	1465
Method of construction of Borden Brook Earth Dam (Hazen)			4947	1323
Submerged pipe is the only job comparable to Spring Valley (Hazen)			4849	1299
Total cost per cu. yd. for Borden Broom Earth Dam (Hazen)			4946	1323
Trenching, cost (Hazen)			5102	1373
Twelve miles of riveted pipe built by Hazen			4376	1168
STANISLAUS WORK				
Excavation cheaper than on Spring Valley (Dillman)	4687	1255		
Excavation done by trenching machine (Dillman)	4687	1255		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
STATE HIGHWAY				
Elimination of, makes Ellis' figures 65c instead of 70c for excavation (Ellis)	4888	1309		
STEAM SHOVEL				
At Pilarcitos one and a fraction swings per minute for a yard and half dipper (Dockweiler)	5208	1404		
Blasting, method used at San Fernando in steam shovel pit (Dockweiler)	5198	1401		
Calaveras Dam, actual cost and estimate (Elliott)			5384	1453
			5387	1454
Calaveras, Elliott has had advantage of Mulholland's and others advice			5387	1454
Calaveras work, very difficult (Elliott)			5386	1453
Capacity Lower Franklin Dam (Los Angeles) (Elliott)			5384	1453
Capacity of (Dillman)	5288–5289	1428		
	5294–5295	1429		
Capacity of, assumed by Dockweiler at Pilarcitos	5208	1404		
Capacity of at Calaveras (Herrmann)			4978	1336
Capacity of at Franklin Canyon (Dockweiler)	5192	1400		
Capacity of compared with New Era Grader (Noyes)	5293	1429		
Capacity San Fernando Dam (Los Angeles)) (Elliott)			5384	1453
Capacity worked on a 260 day per year efficiency basis (Dockweiler)	5210	1404		
Central Reservoir, Oakland, Dockweiler did not make computations on actual time shovel worked on	5041	1356		
Central Reservoir, four men on pay roll, whether shovel works or not (Dockweiler)	5189	1399		
Central Reservoir, number of days worked and elapsed time for steam shovel work (Dockweiler)	5188	1399		
Central Reservoir, Oakland, record of (Dockweiler)	5201	1402		
Central Reservoir, Oakland, rental of and wages of crew	5040	1355		
Central Reservoir, work, size of (Dockweiler)	5186	1398		
Central Reservoir, Oakland, worked 139 days out of 212 (Dockweiler)	5044	1356		
Conditions at San Fernando and Franklin Dams better than at Calaveras (Elliott)			5386	1453
Condition under which it will work (Elliott)			5385–5386	1453
Cost estimate on basis of operating 300 days a year (Dockweiler)	5044	1356		

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
STEAM SHOVEL—Continued.				
Costs 5c per yard more to handle material with than New Era Grader (Dillman)	5288	1428		
	5294	1429		
Costs, method of figuring (Dockweiler)	5043	1356		
Cost of hauling material from steam shovel at Calaveras (Herrmann)			4966–4967	1332
Cost of material placed by steam shovel at Calaveras (Herrmann)			5143	1385
Cost of moving at Calaveras (Herrmann)			4989	1340
Cost of operating (Dillman)	5292	1429		
(Dockweiler)	5211	1404		
Cost of operating at Calaveras (Herrmann)			4979	1337
Cost of placing material less with steam shovel than with scrapers at Pilarcitos and San Andreas (Ellis)	5235	1413		
Cots of transporting (Herrmann)			4977	1336
Cost of transporting into Calaveras			4978	1336
Cost of work Calaveras Dam (Herrmann)			4970	1333
(Hazen)			5110	1375
Cost per mile to ship across country (Dillman)	5130			
Cost 6.3c per cu. yd. for handling material Dockweiler)	5045	1357		
Cost to ship into Pilarcitos (Dockweiler)	5130			
Could not be taken into Pilarcitos on existing roads (Herrmann)			5046	1357
Delays, estimates of, on steam shovel work at Pilarcitos (Dockweiler)	5204	1403		
Delays in work on Los Angeles Aqueduct not recorded (Elliott)			5405	1458
Detail cost of operating (Dockweiler)	5043	1356		
	5047	1357		
Dillman had experience in steam shovel work	5012	1347		
Dockweiler's estimate made allowance of 10% for lay-offs at Pilarcitos	5042	1356		
Dockweiler has frequently seen two dipper loads per minute	5209	1404		
Ellis has had no experience in loading with	5236	1414		
Embankment, Dillman considered use of, in his estimate	5014	1348		
Embankment work, estimated capacity for (Dillman)	5014	1348		
Franklin Canyon Dam, record of work (Dockweiler)	5037	1354		
Hauling from at Calaveras (Herrmann)			4967	1332
Hazen assumed use of, for reproduction of Pilarcitos Dam			4949–4950	1324–1325
Herrmann familiar with rules of steam shovel men			5373	1449

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
STEAM SHOVEL—Continued.				
Lay-offs, Dockweiler's estimate would take care of, at Pilarcitos	5042	1356		
Load more rapidly into cars than into wagons (Ellis)	5236	1414		
Material at Pilarcitos could not be economically segregated by (Elliott)			5396	1457
Material, character of, Los Angeles Aqueduct (Elliott)			5385	1453
Material in vicinity of Pilarcitos Dam could be handled very comfortably (Dillman)	5170	1393		
Method of operating at Calaveras (Herrmann)			4978	1336
Never run 100% of the time (Herrmann)			5147	1386
On Los Angeles earth dams, capacity of (Dockweiler)	5034	1353		
Operating cost of (Dillman)	5293	1429		
(Dockweiler)	5211	1404		
Operating, daily costs (Dockweiler)	5043	1356		
Operating, detail cost of (Dockweiler)	5047	1357		
Out put, estimated at Pilarcitos (Dockweiler)	5042	1356		
Out put, letter from H. L. Jacques on re Los Angeles earth dams (Dockweiler)	5034	1353		
Out put, Los Angeles earth dams based on an average (Dockweiler)	5033	1353		
Percentage of time lost on steam shovel at Calaveras (Herrmann)			5145	1386
			5148	1387
Pilarcitos and San Andreas conditions not comparable to San Fernando and Franklin Dams (Elliott)			5389–5390	1454
Pilarcitos conditions are favorable for (Dillman)	5014	1348		
Pilarcitos could be taken in, over existing roads (Dockweiler)	5047	1357		
Pilarcitos could work advantageously at (Dockweiler)	5197	1401		
Pilarcitos Dam could not be reproduced by (Elliott)			5398	1457
Pilarcitos, Dillman assumed capacity of	5171	1394		
Pilarcitos, method of getting shovel into (Dillman)	5180	1396		
Pilarcitos, method of getting shovel into (Dockweiler)	5187	1398		
Pilarcitos, type of, assumed by (Dockweiler)	5186	1398		
Pilarcitos work compared with Calaveras (Elliott)			5397	1457
Quantities assumed in estimating (Dockweiler)	5038	1355		
San Fernando Dam (Los Angeles) delivery at (Elliott)			5383	1452

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
STEAM SHOVEL—Continued.				
Three or four swings a minute with a dipper (Dockweiler)	5207	1404		
Transporting, detail of, to San Andreas and Pilarcitos (Dockweiler)	5047	1357		
Transportation would be very expensive to get into Pilarcitos (Herrmann)			5129	1381
Upper Franklin Dam (Los Angeles) delivery at (Elliott)			5384	1453
Voids in material, handled by, at San Fernando Dam (Los Angeles) (Elliott)			5391	1455
Wild Horse Dam No. 2 (Vallejo, Cal.) not used on (Noyes)	5262	1422		
Will handle more material than New Era Grader (Dillman)	5291	1429		
STEEL				
And wrought iron pipe f. o. b. San Francisco prices compared (Hazen)			4802	1285
Average price in 1914 was below 1½c on tank plates (Metcalf)			4720	1264
Average prices Metcalf Table			4721–4722	1264–1265
Best 1913 steel would be almost as durable as wrought iron with same kind of coating (Dillman)	4714	1263		
Canadian duty very low (Hazen)			4498	1203
Connecticut River line was steel (Hazen)			4828	
Contracts are taken by mills under various specifications and same steel furnished to fill all (Dillman)	4484	1198		
Costs more to fabricate than iron (Dillman)	4431	1184		
Costs of for, riveted pipe in Spring Valley system 2¼c per lb. f. o. b. San Francisco (Hazen)			4354	1160
Difference between steel sheets and tank plates (Hazen)			4722	1265
Difference between steel sheets and tank plates (Dillman)	4722	1265		
Difference between wrought iron and steel pipes (Dillman)	4413	1179		
Dockweiler used a differential of 1½c a lb. between steel and wrought iron	4452	1191		
Fabrication, bases of assumption that wrought iron would cost less than steel (Dillman)	4699	1259		
Fabrication price, no difference in between steel and wrought iron (Dockweiler)	4453	1191		
Independent inspection not allowed in steel mills (Dillman)	4483	1198		
Inspection, Dillman has not faith in inspection of steel in Eastern mill	4693	1257		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
STEEL—Continued.				
Inspection of steel armor plates for Government at Harrisburg (Dillman)	4484–4485	1198–1199		
Is being used because it is cheaper, stronger and obtained in larger plates (Hazen)			4371	1166
Largely replacing wrought iron for large riveted pipes in United States (Hazen)			4366–4367	1164–1165
Lasting qualities of wrought iron compared with (Hazen)			4573	1225
Maximum pressure of Monterey Water Co.'s steel pipe (Rhodes)	4738	1267		
Method of manufacturing for riveted pipe (Hazen)			4348–4349	1157
Montague, W. W., made steel pipe for Monterey Water Co. (Rhodes)	4737	1267		
Monterey Water Co., manufacture of steel pipe for, general remarks (Rhodes)	4744–4749	1268–1270		
Monterey Water Co., length and size of pipe made for, by W. W. Montague Co.	4738	1267		
Monterey Water Co., machinery used in manufacture of steel pipe for (Rhodes)	4742–4743	1268		
Monterey Water Co., maximum pressure of steel pipe (Rhodes)	4738	1267		
Monterey Water Co., method of caulking steel pipe for (Rhodes)	4751	1270		
Monterey Water Co., method of determining average consumption of power in making pipe for (Rhodes)	4741	1268		
Monterey Water Co., power required to drive compressor in the manufacture of pipe for (Rhodes)	4753	1271		
More information on steel for riveted pipe than on wrought iron (Hazen)			4351	1159
Pipes, Baker Iron Works quotes 3.7 cents per pound f. o. b. Los Angeles (Dockweiler)	4639	1243		
Pipes, Dillman prefers wrought iron to steel	4692	1257		
Pipes, has not the durability that wrought iron pipe has (Hazen)			4540	1214
Pipes, is not as preferable as wrought iron			4371	1166
Pipes, of the same age has 13 or 14% less carrying capacity than old wrought iron pipe of Spring Valley (Hazen)			4367	1165
Pipes, would have to be of greater diameter to have same capacity as iron pipe (Hazen)			4367	1165
Plates bought to weight are 8 to 10% lighter and cheaper than plates bought to gauge (Hazen)			4528	1211
Price dropped because of Panama Canal opening (Dillman)	4676	1252		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
STEEL—Continued.				
Price for 1914 was lower than 1913 on the average (Dillman)	4723-4724	1265		
Price higher today than in 1913 (Dillman)	4675	1252		
	4678	1253		
Price of, has been low since European war (Dockweiler)	4675	1252		
Price on, obtained from "Iron Age" (Dillman)	4719	1264		
Principal difference between wrought iron job and steel job is cost of metal (Hazen)			4802	
Quotations for 1913, 14, 15 (Dillman)	4719	1264		
Quotations from "Iron Age" were on steel plates less than ¼" (Dillman)	4721	1264		
Records of work in steel cannot be used without modifications in estimates for wrought iron (Hazen)			4351	1159
Rhodes did not check cost with Montague shop cost on Monterey Water Co. steel pipe	4752	1271		
Rhodes does not know what Monterey Water Co. paid for steel pipe	4750	1270		
Rhodes inspected steel pipe for Monterey Water Co.	4737	1267		
Rhodes kept analysis of shop costs on Monterey Water Co.'s steel pipe	4739	1267		
Rhodes obtained wages paid on steel pipe for Monterey Water Co. from pay rolls	4752	1271		
Sheets are manufactured differently from steel plates (Hazen)			4723	1265
Specifications for Monterey Water Co. steel pipe very rigid (Rhodes)	4738	1267		
Specifications, summarization of, for Monterey Water Co.'s steel pipe (Rhodes)	4739	1267		
Spring Valley submerged pipe is steel (Hazen)			4828	
Steel pipe corrodes, and early lines will disappear in time (Hazen)			4372	1167
Steel pipe perforations caused by surface defects in plates (Hazen)			4547	1216
Tests made on New Bedford pipe line (Metcalf)			4544	1215
The 20% additional for wrought iron pipe as compared to steel is for fabricated pipe (Dockweiler)	4804	1286		
To replace iron pipe with steel would cost substantially more (Hazen)			4370	1166
Two per cent heavier than wrought iron (Hazen)			4526	1210
Will rust faster than iron (Dillman)	4414	1179		
Would have greater carrying capacity when new than old wrought iron pipe of Spring Valley (Hazen)			4370	1166

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
STEEL—Continued.				
Wrought iron cost 70% more than steel f. o. b. San Francisco (Hazen)			4802–4803	1285
Wrought iron has no advantage over steel as long as coating is intact (Dillman)	4415	1179		
Wrought iron lasts longer (Hazen)			4574	1225
Wrought iron more durable than (Dillman)	4692	1257		
	4694			
See also Pipe Riveted				
STIPULATIONS				
Peninsula lands, values stipulated in re percentage reductions in value of lands to 1909 (Olney)			4161	
Pleasanton lands, discussion in re stipulation as to value of lands prior to 1913			4160	
STOCK				
Estimated cost of (Ellis)	5254	1419		
Rental, cost of, at Calaveras (Herrmann)			5140	1384
Spring Valley Co. cared for and fed stock at Calaveras (Herrmann)			5140	1384
STOCKTON STREET TUNNEL, SAN FRANCISCO				
Cement prices (Ellis)	5522	1497		
STONE DAM AQUEDUCT 44"				
Analysis shows actual time and cost (Lawrence)			4402	1176
STRIPPING				
By hydraulic process at Calaveras estimated by (Herrmann)			4967	1332
Cost of, at Calaveras (Herrmann)			4966	1331
			5123	1379
Cost of Calaveras borrow pits (Herrmann)			5122	1379
Cost of, at Pilarcitos (Herrmann)			5122–5123	1379
Cost of power for Calaveras (Herrmann)			5122–5123	1379
Crystal Springs Dam, description of work (Lippincott)			5531	1500
Crystal Springs Dam, estimated cost (Lippincott)			5484	1485
			5531	1500
Crystal Springs Upper Dam, not included in volume (Hazen)			5093	1390
Earth dams, unit cost and method of computing (Dockweiler)	5031	1352		
Estimated cost of, at Pilarcitos and San Andreas Dams (Ellis)	5232	1412		
Freeman site, Calaveras, done in a rush (Herrmann)			5151	1388
Gibraltar Dam, cost of (Lippincott)			5484	1485
			5532	1500
Government Dam, cost of (Lippincott)			5484	1485

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
STRIPPING—Continued.				
Method of estimating cost of Pilarcitos Dam (Herrmann)			5124–5125	1379–1380
Method of estimating for earth dams (Herrmann)			5122	1379
Pilarcitos Reservoir, cost of (Herrmann)			4965–4966	1331
Roosevelt Dam, bids for (Lippincott)			5533	1500
Roosevelt Dam, cost of (Lippincott)			5484	1485
STRUCTURES				
Of Spring Valley Water Co. well designed and built (Hazen)			4284–4287	1136–1137
Seventh Ave. Tunnel has nothing to do with riveted pipe lines, grouped for convenience (Hazen)			4372	1167
STRUCTURES, APPURTENANT				
11, page 21, cost compared with Dockweiler and Dillman estimates (Hazen)			4380	1169
11, page 21, San Andreas pipe line, Dillman's total cost includes overhead	4380	1169		
11, page 21, San Andreas pipe line, Dockweiler's total cost does not include overhead	4380	1169		
Overhead, Hazen 28.8%, Dillman 15½%	4381	1169		
San Andreas 44" pipe line, unit prices (Dillman)	4384	1169		
	4419	1181		
San Andreas 44" pipe line, unit prices, Hazen, Dockweiler, Dillman			4381	1169
7, page 21, San Andreas pipe line, cost of per foot (Hazen)			4378	1169
STRUCTURES, AUXILIARY				
Crystal Springs Dam, cost of concrete (Hazen)			5417	1462
STRUCTURES, SPECIAL				
Cost of along certain riveted pipe lines of Spring Valley (Hazen)			4373	1167
SUNOL FILTER GALLERIES				
Concrete, estimated cost of (Hazen)			5441	1471
			5457	1477
Sheeting, description of (Hazen)			5455–5456	1476
Timbering of, not included in estimate (Hazen)			5457	1477
SUPERIOR, WIS.				
Hazen supervised laying a 24" submerged pipe			4768	1275
Submerged pipe, Hazen does not know cost			4830	1293
Submerged pipe is cast iron (Hazen)			4829	1292
Submerged pipe, method of laying (Hazen)			4830	1293
SUTTER CREEK SYPHON				
Excavation cost 47c (Ellis)	4887	1308		

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
SYPHONS				
Antelope, Los Angeles Aqueduct, cost of (Hazen)			4550	1217
Antelope, Los Angeles Aqueduct, weight records not correct (Metcalf)			4553	1218
Cost of hauling Antelope plant (Dockweiler)	4557	1219		
Costs of ¼" syphon on Los Angeles Aqueduct (Hazen)			4502	1204
Fabrication, cost of, Los Angeles Aqueduct (Hazen)			4551	1217
Los Angeles pipe not dipped but painted (Hazen)			4555	1218
Merced and Pleasanton pipe lines have small amount of inferior pipe (Hazen)			4522	1209
Notes on cost, Los Angeles Aqueduct (Hazen)			4549	1217
Pilarcitos line, roads included in Spring Valley estimate (Hazen)			4560	1220
TABEAUD DAM				
Borrow-pits, general remarks (Ellis)	5251–5252	1418		
Borrow-pits, location of (Ellis)	5243	1416		
Constructed by E. B. & A. L. Stone Co. (Ellis)	5223	1408		
Construction of, Ellis familiar with	5224	1409		
Construction, method used (Ellis)	5224	1409		
Construction, no trouble with water (Ellis)	5246	1417		
Contract price of (Ellis)	5224	1409		
Contractor compelled to live up to specifications (Ellis)	5250	1418		
Contractors did not lose money (Ellis)	5243	1416		
Contractors had no cost for water (Ellis)	5246	1417		
Cost of complete, not known (Ellis)	5245	1416		
Dimensions of (Ellis)	5230	1411		
	5252	1418		
Embankments, cost of, less than at Blue Lakes (Ellis)	5255	1419		
Embankment, portion of, built by company most expensive (Ellis)	5245	1416		
Labor, roads, etc., general remarks on (Ellis)	5248–5250	1417–1418		
Material, character of (Ellis)	5243	1416		
Puddle-wall completely through dam, was abandoned (Ellis)	5228	1411		
Puddle was built without (Dillman)	5181	1396		
Puddling, cost of (Ellis)	5245	1416		
Rock facing to be placed by contractor (Ellis)	5226	1409		
Rolling embankment, method used (Ellis)	5257	1420		
Schuyler's report on, extracts from (Ellis)	5228–5229	1411		
Settlement (Ellis)	5235	1413		
	5241	1415		
Settlement less than at Pilarcitos Dam (Ellis)	5241	1415		
Specifications, extracts from (Ellis)	5225–5228	1409–1411		

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
TABEAUD DAM—Continued.				
Specifications, reasons for rigid (Ellis)	5230	1411		
Stone facing was not hand laid rip-rap (Ellis)	5226	1410		
Total yardage (Ellis)	5244	1416		
Wages paid (Ellis)	5233	1413		
Working season good (Ellis)	5234	1413		
TABLES				
Average prices on steel, Metcalf Table			4721–4722	1264–1265
Dillman explains how he made and applied, showing cost of wrought iron pipe	4417	1181		
Dillman's showing weight and cost per lineal foot of wrought iron pipe	4416	1180		
Dorward's showing cost fabricating and laying original Spring Valley pipes by Risdon Iron Works	4891	1309		
	4899	1311		
Healy & Tibbit's showing detailed cost of laying submerged pipe (Dockweiler)	4782–4783	1279–1280		
TAMPING				
Backfill practice is to have two tampers and one shoveler (Hazen)			5352	1442
Spring Valley pipe, methods used (Lawrence)			5352	1442
TARRING				
Flumes, estimated cost of (Herrmann)			5372	1449
TEAMING				
Cost of teams at Calaveras (Herrmann)			5315	1434
Detail cost of (Dockweiler)	5205	1403		
Estimated cost of, Pilarcitos (Ellis)	5254	1419		
In re riveted pipe, teams were hired by the day (Lawrence)			5314	1434
Part of original cost to which 10% overhead was added by Risdon Iron Works (Dorward)	4905	1312		
Pilarcitos Dam, Dockweiler would not pay for teams during delays and lay-offs	5205	1403		
Wage of teamsters at Calaveras (Herrmann)			5315	1434
TESTS				
All pipe I had to do with was bottle tight before dipped and tested at 300 lbs. and special tested at 1000 lbs. pressure (Hazen)			4757	1272
Hazen never heard of running bran through pipe to make caulking tight			4761	1273
Pressure on San Diego riveted pipe (Dockweiler)	4795	1283		
THICKNESS				
No. 9 iron discussed			4463–4468	1194–1195
Of pipe were determined from the inventory (Dillman)	4428	1183		

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
THORNYCROFT IRON WORKS				
Total tonnage of Scotch plates and average age of plates made for Spring Valley Water Co. (Hazen)			4310	1143
TIDAL CURRENTS				
Very strong at Ravenswood (Hazen)			4834	1294
TIMBERING				
Cost of, at Pilarcitos and San Andreas (Dillman)	5156	1389		
Earth dams, detail costs (Dockweiler)	5050	1358		
Earth dams, Dockweiler's estimate based on Emory's testimony and Spring Valley records	5051	1359		
Sunol Filter Galleries, not included in estimate (Hazen)			5457	1477
TON-LONG AND SHORT				
Difference between would be 12% in cost of pipe (Dillman)	4689	1256		
Dillman not sure pipe is sold by long ton (Dillman)	4689	1256		
TORONTO, CANADA				
Labor, cost of (Hazen)			5446	1473
Material, cost of (Hazen)			5446	1473
TOWERS, GATE				
Crystal Springs Dam, cost of excavation (Lippincott)			5534	1500
TRANSPORTATION				
Cost of, for steam shovel (Herrmann)			4977	1336
Cost of, on pipe from shop to ditch, Alameda pipe line (Hazen)			4343	1155
Cost of steam shovel into Calaveras			4978	1336
Dorward does not know actual cost of Spring Valley riveted pipe	4902	1311		
Material for Crystal Springs Dam difficult (Hazen)			5411	1460
TRENCHING				
And back-filling, Contra Costa Water Co. cost 45c per foot of 24" pipe (Dockweiler)	4801	1285		
Calaveras Dam, cost of			4983	1338
(Herrmann)			5155	1389
Calaveras Dam, quantities and material used in estimate of (Herrmann)			4980	1337
Central Reservoir, Oakland, description of puddle core and trench (Dockweiler)	5200	1402		
Cost of lagging at Pilarcitos and San Andreas (Dillman)	5156	1389		
Crystal Springs Upper Dam, not included in volume (Hazen)			5093	1370
Difference in cost of, between San Andreas and Pilarcitos Dams (Dockweiler)	5068	1364		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
TRENCHING—Continued.				
Dillman assumed he would not encounter any hard rock at Pilarcitos Dam	5173	1394		
Dry Canyon Dam, Los Angeles Aqueduct, cost of (Herrmann)			4981	1337
Earth Dams, character of materials shown by inspection below Pilarcitos (Dockweiler)	5052	1359		
Earth Dams, detail of cost (Dockweiler)	5049	1357		
Earth Dams, detailed operations assumed (Dockweiler)	5049	1357		
Earth Dams, Dillman did not consider lagging in his estimate (Dillman)	5021	1349		
Earth Dams, Dockweiler's estimate based on Emory's testimony and Spring Valley records	5051	1359		
Earth Dams, Dockweiler estimated on a standard Spring Valley trench as taken from the plans	5048	1357		
Earth Dams, Dockweiler figured 9-hour day, labor $2.50	5048	1357		
Earth Dams, Hazen considered lagging in his estimate (Hazen)			5022	1350
Earth Dams, Herrmann allowed for lagging (Herrmann)			5023	1350
Earth Dams, labor costs (Dockweiler)	5050	1358		
Earth Dams, lagging not included in Dillman's original estimate	5168	1393		
Earth Dams, unit costs (Dillman)	5021	1349		
	5053	1359		
Earth Dams, unit costs on San Andreas (Dillman)	5027	1351		
Earth Dams, wages for (Dockweiler)	5050	1358		
Grubbing very heavy in trench excavation on Bull Run pipe line, Portland, Ore. (Dillman)	4508	1206		
Haiwee Dam, North, cost of (Herrmann)			4982	1338
Haiwee Dam, South, cost of (Herrmann)			4982	1338
Hazen assumed use of machine in his estimates (Hazen)			4815	1289
Howard cut, water at 40 feet			5533	1500
It was not important to know depth of trench in estimating Pilarcitos Dam (Dillman)	5166	1392		
Lawrence has had no experience with trenching machines			5312	1434
Los Angeles Aqueduct costs (Herrmann)			5155	1388
Modesto Irrigation District cost (Herrmann)			4982	1338
			5155	1389
On Bull Run pipe line, Oregon, Hazen familiar with			4507	1206
Pilarcitos Dam, Dillman would use a derrick in trench construction	5173	1394		

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
TRENCHING—Continued.				
Pilarcitos Dam, unit cost of (Hazen)			4951	1325
Pilarcitos Dam very expensive (Hazen)			4951–4952	1325–1326
Riveted pipe, Ellis has not excavated any trenches in roads	4994	1341		
Riveted pipe, excavations for wide trenches more expensive than for narrow (Ellis)	4995	1341		
Riveted pipe, unit prices for in State Highway (Ellis)	4997	1342		
Springfield System, cost of, on (Hazen)			5102	1372
There is a saving in using trenching machine over hand labor (Dockweiler)	4814	1288		
TRENCHING MACHINES				
Lawrence had no experience with			5312	1434
Stanislaus work excavation done by (Dillman)	4687	1255		
TRESTLES				
Cost of carpenters and labor for Baden screen tank trestle (Lawrence)			5330	1437
San Andreas pipe line, location of (Lawrence)			5329	1437
There are nine between screen tank and Baden (Lawrence)			5331	1437
TRUCKS				
Cost of operating a truck, hauling for flumes (Herrmann)			5368	1447
TUBERCULATION				
Difference between, and corrosion (Hazen)			4315	1145
New Bedford pipe much more tuberculated and pitted than Spring Valley system (Metcalf)			4578	1227
New Bedford riveted pipe (Metcalf)			4544	1215
TUNNELS				
Brick work, Lippincott figured on brick in Crystal Springs only			5485	1486
			5534	1501
Cement price, Stockton Street Tunnel San Francisco (Ellis)	5522	1498		
Crystal Springs Dam, brick assumed by Lippincott at $50 per M			5485	1486
Crystal Springs Dam, cement required for brick work (Lippincott)			5534	1501
Crystal Springs Dam, Lippincott assumed concrete in the reproduction of the Peninsula system			5535	1501
Crystal Springs Dam, reasons for high cost (Lippincott)			5485	1486
Elizabeth Tunnel excavating shaft, cost of (Lippincott)			5534	1500
Seventh Ave. Tunnel has nothing to do with cost of riveted pipe lines (Hazen)			4372	1167

	Defendant		Plaintiff	
TWIN LAKES	Record	Abstract	Record	Abstract
Cost of embankment (Ellis)	5254	1419		
UNDER-RIVETING				
Meaning of (Dockweiler)	4601	1233		
UNION IRON WORKS				
Bid on 44" riveted pipe $4.35 per foot or .036 per lb. (Dockweiler)	4471	1195		
UNIVERSITY MOUND PIPE LINE				
44", 37" and 37½" pipe, page 331 Inventory are part of University Mound line (Hazen)			4685	1254
VALLEJO DAM				
Is just as good as San Leandro Dam (Dillman)	5181	1396		
Was built without puddle (Dillman)	5181	1396		
VALUATION				
Crystal Springs Dam, made by Lippincott as of December 31, 1913			5467	1480
Of buildings, the comparative figures were segregated from the exhibits and are comparable (Metcalf)			4824	1291
Upper Crystal Springs Dam, more than simple embankment value (Hazen)			5074	1365
VALUES				
Basis of Dockweiler did not get figures on submerged pipe work, other than Spring Valley (Dockweiler)	4880	1306		
Basis of records of Spring Valley, etc., submerged pipe (Dockweiler)	4860	1301		
	4876	1305		
Buildings, Dillman, Dockweiler, Hazen	4822	1291		
Pleasanton Ranch houses valued at $135,000 (Dockweiler)	4823	1291		
Submerged pipe, estimates of (Dillman, Dockweiler)	4826	1291		
	4861	1301		
	4878	1305		
VANCOUVER				
Labor conditions (Hazen)			4840	1296
VANCOUVER PIPE LINE				
Submerged pipe, condition of laying similar to those of Spring Valley (Hazen)			4768	1275
Submerged pipe, cost of (Hazen)			4769	1275
Submerged pipe, cost of material (Hazen)			4838	1295
Submerged pipe, depth of water (Hazen)			4839	1296
Submerged pipe, description of (Hazen)			4769	1275
Submerged pipe, length of (Hazen)			4838	1295
Submerged pipe, method of laying (Hazen)			4839	1296
VICTORIA, B. C.				
Fabrication of plates scarcely comparable to Spring Valley plates (Hazen)			4513	2107
Plates were fabricated in Canada (Hazen)			4512	1207

	Defendant		Plaintiff	
WACHUSETT DAM (BOSTON)	Record	Abstract	Record	Abstract
Description of (Hazen)			5423	1465
WAGES				
And fabrication cost in re steel pipe have not dropped since European war (Dockweiler)	4675	1252		
Boiler-makers, reduction of, in 1913 was an error (Lawrence)			5344	1441
Carpenters (Lawrence)			5306–5308	1432–1433
Carpenters on riveted pipe work (Lawrence)			5328	1437
Dorward knew wages of men employed at Risdon Iron Works	4893	1310		
Eight-hour day is observed in San Mateo County and 9 hours in Alameda County (Lawrence)			4409	1178
Figured on for labor at Pilarcitos Dam by (Ellis)	5233	1413		
Foreman on riveted pipe work (Lawrence)			5327	1436
.....			5336	1439
.....			5343	1440
For painting joints, riveted pipe (Lawrence)			5331	1437
Four men are on pay roll, whether steam shovel works or not, at Central Reservoir (Dockweiler)	5189	1399		
Laborers (Lawrence)			5306–5308	1432–1433
Labor, for clearing earth dams (Hazen)			5099–5100	1372
Labor on earth dams $2.50 per day in 1913 (Dillman)	5015	1348		
Labor, trenching, earth dams (Dockweiler)	5050	1358		
Labor, trenching, earth dams, Dockweiler figured 9-hour day at $2.50 per day	5048	1357		
Labor, wage schedule used in estimating Peninsula Dam (Herrmann)			4973	1334
Modesto District Dam schedule (Herrmann)			5142	1385
Of a caulker (Dockweiler)	4645	1245		
Of crew and rental of steam shovel Central Reservoir, Oakland (Dockweiler)	5040	1355		
Rhodes obtained wages paid on Monterey Water Co. steel pipe from pay rolls	4752	1271		
Tabeaud Dam (Ellis)	5233	1413		
Teamsters at Calaveras (Herrmann)			5315	1434
The increase from 1884 to 1913 was 12% (Dorward)	4917	1315		
There is not much difference in the wage schedule between Los Angeles and San Francisco (Dockweiler)	4455	1192		
WASHINGTON, D. C.				
Labor, cost of (Hazen)			5445	1473
Material, cost of (Hazen)			5444	1473
Percentage on riveted steel pipe line higher than 10% for accessories (Hazen)			4362–4363	1163
Riveted pipe line built by Hazen			4376	1168
Steel pipe line dipped with asphalt (Hazen)			4545	1215

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
WASTE				
Flume lumber figured at 5% (Herrmann)			5370	1448
Flumes, made no allowance for (Lawrence)			5370	1448
Manufacture of pipe (Hazen)			4309	1143
WATCHMAN				
Time on San Andreas pipe line explained by (Lawrence)			5302	1432
WATER				
Contractor had not cost of, on Tabeaud Dam (Ellis)	5246	1417		
Depth of, Vancouver line (Hazen)			4839	1296
Depth of Portland submerged pipe line (Dillman)	5007	1346		
No trouble with during construction of Tabeaud Dam (Ellis)	5246	1417		
Quality, good, Spring Valley Water Co. (Hazen)			4276	1133
Quality of, improved by Crystal Springs Upper Dam (Hazen)			5105	1374
Supply at Calaveras and Pilarcitos Dams (Herrmann)			5115–5116	1377
WATER WORKS				
Construction on Pacific Coast more expensive than on Atlantic (Hazen)			4294–4295	1139–1140
WEIGHTS				
Actual, of bells on submerged pipe is more than the amount shown in the agreed schedule (Hazen)			4776	1278
Actual, of coating in Spring Valley system (Hazen)			4333	1152
Actual, of wrought iron pipe in system (Hazen)			4333	1152
Alameda pipe line taken from specifications and contracts (Lawrence)			5298	1430
Alameda pipe line taken from Spring Valley records (Lawrence)			5298	1430
A long ton is never known in the riveted pipe business (Hazen)			4530	1212
Coating on pipe runs close to loss of metal in manufacture (Hazen)			4337	1153
Coating on Spring Valley pipe equals 9.4% of metal (Hazen)			4343	1155
Difference between long and short ton would be 12% in the cost (Dillman)	4689	1256		
Difference in Hazen's weight of submerged pipe			4778	1278
Difference in weight of 8 or 10% in buying plates for riveted pipe by weight and gauge (Hazen)			4351	1159
Dillman's compared to Hazen's and Dockweiler's (Dillman)	4700	1259		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
WEIGHTS—Continued.				
Dillman not sure pipe is sold by long ton	4689	1256		
Dillman says if he and Hazen had come together, they could have agreed on weights of riveted pipe	4710	1262		
Dillman's table explained	4417	1181		
Dillman's table showing weight and cost per lineal foot	4416	1180		
Dillman thinks Hazen's formula in re thin plates is wrong	4701	1260		
	4706			
Dillman thinks his chart nearer truth than Hazen formula	4703	1260		
Dockweiler's weight and cost per lb. of lead on submerged pipe	4780	1279		
Discussion in re weights different engineers for pipe	4439			
Explanation of page 15, Hazen's schedule			4525–4526	1210
Hazen 8¼% above Spring Valley's estimated weights			4330	1151
Hazen formula explained (Dillman)	4708	1261		
(Hazen)			4708	1261
Hazen formula fair, represents weight of all ordinary steel pipe			4527	1211
Hazen formula for computing weight of pipe			4333	1151
Hazen's formula for computing weight of welded submerged pipe (Hazen)			4771–4772	1276–1277
Hazen's formula on weights does not apply to Spring Valley pipes			4527–4528	1211
Hazen's formula 13% more than actual weight of metal			4334	1152
Hazen's total weight of 16" submerged pipe			4778	1278
Hazen's weight of lead on submerged pipe			4780	1279
If pipe weight checks, Hazen formula would be right (Dillman)	4708	1261		
Is possible that Spring Valley pipes will not measure in weight with Dillman's chart	4704	1260		
Lacy Bros.' letter from, in re weights riveted pipe (Dockweiler)	4447	1189		
Lawrence weights were used with some modifications (Dillman)	4710	1262		
Los Angeles Aqueduct, records of Antelope syphon not correct (Metcalf)			4553	1218
Method of computing weights riveted pipe (Dockweiler)	4438	1186		
Of different sizes of pipe on San Andreas line (Dockweiler)	4437	1186		

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
WEIGHTS—Continued.				
Of various sizes of pipe as per Lacy Bros. (Dockweiler)	4446	1189		
Other information does not agree with Lawrence weights (Searls)	4817	1290		
Per cubic yard of puddle core at Pilarcitos Dam (Dillman)	5160	1391		
Pipe bought by the foot thinner (Hazen)			4529	1212
Pipe bought to gauge is thinner on edges than in middle (Hazen)			4531	1212
Pipe bought to weight 8 to 10% less than if bought to gauge (Hazen)			4529	1212
Pipe finished, weighs 10% more than metal (Hazen)			4496	1202
Pipe for P. P. I. E. made by Schaw-Batcher was weighed after dipping and paid for by weight (Rhodes)	4756	1272		
Pipe, majority of Spring Valley bought to (Hazen)			4528	1211
Pipe, most of Los Angeles bought to (Hazen)			4528	1211
Portland pipe bought to gauge (Hazen)			4528	1211
Records of mill show weights of Spring Valley Water Co.'s submerged pipe (Hazen)			4865	1302
Risdon Iron Works' method of obtaining, on Spring Valley riveted pipe (Dorward)	4908	1313		
Rivets in pipes amount to 4% (Hazen)			4330	1150
Rock, Crystal Springs Dam (Lippincott)			5477	1483
San Andreas line, Dillman has not figured total weight of the line	4422	1182		
Sand, Crystal Springs Dam, weight of (Lippincott)			5476	1483
Specifications 268, Los Angeles were drawn on a weight basis (Dockweiler)	4610	1235		
Steel plates bought to weight are 8 to 10% lighter and cheaper than plates bought to gauge (Hazen)			4528	1211
Submerged pipe, other information does not agree with Lawrence weights (Searls)	4817	1290		
3% to carry overhead (Dockweiler)	4441	1187		
3% waste in manufacture (Dillman)	4711	1262		
Used by Dockweiler, and method of obtaining	4778–4779	1278–1279		
Wrought iron 2% lighter than steel (Hazen)			4526	1210
WENZELBURGER'S REPORT				
Cost, actual, of Crystal Spring Dam (Greene)			5434	1469
Cost of Crystal Springs Dam, segregation of			5434	1469
Crystal Springs Dam, adjusted to Hazen's report			5434	1469
Crystal Springs Dam, cost of, compared with Hazen's estimate			5436	1470

	Defendant		Plaintiff	
	Record	Abstract	Record	Abstract
WESTERN PIPE AND STEEL CO.				
Bids on San Diego riveted pipe (Dockweiler)..	4797	1284		
Knew Dockweiler was making valuation for San Francisco (Dockweiler)	4616	1237		
Quotations from in re fabrication riveted pipe (Dockweiler)	4449	1190		
Specifications, Dockweiler did not submit, when asking for prices.....	4616	1237		
Two riveted pipe lines built for Spring Valley were inferior (Hazen).....			4521	1209
.....			4523	1210
Work, 9-hour day, Schaw-Batcher, 8-hour pay same ratio (Dockweiler)	4625	1240		
WHITE CO., J. G.				
Cost records, copies by Los Angeles (Dockweiler)	4585	1229		
WILD HORSE DAM No. 2 (VALLEJO, CAL.)				
Borrow-pits, description of (Noyes).....	5274	1425		
Borrow-pits, length of haul from (Noyes).....	5270	1424		
Brush, etc., character of (Noyes).....	5269	1424		
Built by Lewis Moring (Noyes).....	5261	1421		
Built when construction was cheap (Noyes)...	5285	1427		
Clearing, contract price for (Noyes).....	5269	1424		
Clearing, cost of (Noyes).....	5269	1424		
Construction, difficulties in (Noyes).....	5270	1424		
Construction, method used (Noyes).....	5262	1422		
Contractor's cost account verified (Noyes).....	5266	1423		
Contractor owned his stock (Noyes).....	5285	1427		
Contractor's profit (Noyes).....	5267	1423		
Contract price (Noyes)	5267	1423		
Core wall, had none (Noyes).....	5261	1421		
Description of (Noyes).....	5261	1421		
Dillman bid 30c a yard but was not lowest bidder	5011	1347		
Dimensions of (Noyes)	5261	1421		
Embankment, cost of (Noyes).....	5268	1424		
Excavation, cost of (Noyes).....	5269	1424		
Labor, cost of, for 10-hour day (Noyes).....	5271	1425		
Leakage, none (Noyes).....	5265	1423		
Material, character of (Noyes).....	5262	1422		
New Era Grader, description of (Noyes).....	5268	1424		
Rip-rap, cost of (Noyes)	5273	1425		
Rip-rap did not include quarrying (Herrmann)			5356	1444
Rip-rap laid in gravel (Noyes).....	5271	1425		
Settlement in (Noyes)	5265	1423		
Specifications, extracts from (Noyes).....	5263	1422		
.....	5265	1423		
.....	5270	1425		
Steam shovel not used (Noyes).....	5262	1422		

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
WILD HORSE DAM No. 2 (Vallejo, Cal.)—Contd.				
Terms of contract (Noyes)	5268	1424		
Total cost (Noyes)	5267	1423		
Yardage (Noyes)	5261	1421		
WILHELM, GEORGE				
Had charge of construction of Central Reservoir, Oakland	5203	1403		
WIND				
Higher at Dumbarton than at Portland, Ore. (Dillman)	5007	1346		
Would cause extra expense in submerged pipe construction (Dillman)	5010	1346		
WINNIPEG, CANADA				
Hazen estimated riveted pipe line			4376	1168
Pipe on Winnipeg job special (Hazen)			4498	1203
WROUGHT IRON				
And steel job principal difference between is cost of metal (Hazen)			4802	
Best 1913 steel would be almost as durable as wrought iron with same kind of coating (Dillman)	4714	1263		
Better than steel for pipe (Hazen)			4371	1166
Capacity 13 or 14% greater than steel pipe of same age (Hazen)			4367	1165
Difference between wrought iron and steel pipes (Dillman)	4413	1179		
Dillman's estimate based on reproduction cost of wrought iron pipe	4415	1179		
Dillman explains how he made and applied his table showing cost of wrought iron pipe	4417	1181		
Dillman had no experience in wrought iron pipe	4690	1256		
Dillman has not heard of any wrought iron pipe being laid in recent years, outside of Spring Valley plant	4415	1179		
Dillman prefers wrought iron to steel for pipe	4692	1257		
Dillman never laid any wrought iron pipe	4413	1179		
Dillman's table showing cost of wrought iron pipe	4416	1180		
Dockweiler made no difference in the fabrication price between steel and wrought iron	4453	1191		
Dockweiler used a differential of 1½c a lb. between steel and wrought iron	4452	1191		
Fabrication, basis of assumption that wrought iron would cost less than steel (Dillman)	4699	1259		
For riveted pipe could not be manufactured on large scale today (Hazen)			4371	1166
General remarks on use and advantage for pipe (Hazen)			4542	1215

	Defendant Record	Defendant Abstract	Plaintiff Record	Plaintiff Abstract
WROUGHT IRON—Continued.				
Has no advantage over steel as long as the coating is intact (Dillman)	4415	1179		
Hazen doubts if large wrought iron pipe is going to be laid			4541	1214
In old Spring Valley riveted pipe lines have lasted because of wonderful resistance to corrosion (Hazen)			4367	1165
Inspection proper to have (Dillman)	4643	1257		
Is worked easier than steel (Dillman)	4413	1179		
Lasting qualities compared with steel (Hazen)			4573	1225
Lasts longer than steel (Hazen)			4540	1214
			4574	1225
Less information on, for riveted pipe than on steel (Hazen)			4351	1159
Material, important for small pipe (Hazen)			4540	1214
Metcalf did not make any detailed estimate of wrought iron on Spring Valley system			4578	1227
More durable than steel (Dillman)	4692	1257		
	4694			
Plates cost 70% more than steel f. o. b. San Francisco (Hazen)			4802	1285
Prices compared to steel f. o. b. San Francisco (Hazen)			4540	1214
Quotations from Allan Wood added 25% to cost of steel (Dillman)	4695	1258		
Records of work in steel can not be used without modification in estimates for (Hazen)			4351	1159
Replaced by steel for large riveted pipes in United States (Hazen)			4366–4367	1164–1165
The shift from, to steel, in the construction of pipe lines was too fast (Hazen)			4541	1214
The small size of wrought iron plates is a disadvantage in building pipes (Hazen)			4542	1215
The 20% additional for wrought iron pipe as compared to steel is for fabrication (Dockweiler)	4804	1286		
Two per cent lighter than steel (Hazen)			4526	1210
Wonderful structural material for pipes (Hazen)			4541	1214
See also Iron				
YONKERS, N. Y.				
Labor, cost of (Hazen)			5446	1473
Material, cost of (Hazen)			5446	1473